

SCIENCE

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FRIDAY, MAY 29, 1903.

HENRY BARKER HILL.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

HENRY BARKER HILL, professor of chemistry and director of the Chemical Laboratory of Harvard College, died on April 6, 1903, in the fifty-fourth year of his age, after a brief but painful illness. His death makes an irreparable gap in the ranks of American scientific men.

Professor Hill's life was a quiet one—the life of an investigator in a field of scientific rather than of public interest. His delicate health for years and his retiring disposition prevented many of his colleagues from knowing him well; hence his true worth has perhaps not been fully appreciated by those outside the circle of his intimate friends.

The Reverend Thomas Hill, his father, was at one time president of Antioch College, and later, from 1862 to 1868, president of Harvard University. In 1845 Thomas Hill married Miss Anne Foster Bellows, and on April 27, 1849, Henry Barker Hill was born. Having spent his later school days in Cambridge, he entered Harvard College in 1865 at the age of sixteen years. Here his unusual versatility was soon recognized by his early companions, who felt that with so many possibilities the choice of a profession must be difficult. His mathematical ability was rare; he possessed a keen and sympathetic taste for music, and his literary and philological in-

stinets were strong. When the decision was made, however, there was no swerving or faltering in the path. After graduation in 1869, he went to Berlin, where he studied chemistry for a year with A. W. Hofmann. On returning to America, he was made assistant in chemistry in Harvard University, a post which he held for four years. At the age of twenty-five he was promoted to an assistant professorship, and ten years afterwards became full professor. The always increasing administrative duties of the growing department of chemistry were divided on the death of Professor Josiah Parsons Cooke in 1894, and Professor Hill was given the responsibility of the management of the laboratory as director, while Professor Charles Loring Jackson was made chairman of the department. During the nine years of his directorship, Professor Hill, with the utmost ingenuity, remodeled and enlarged an old and unsuitable building with such success as to provide available accommodation for over seven hundred men, and to increase immensely the efficiency of the institution. Administrative work of this kind was undertaken with the conscious sacrifice of some of his dearly cherished scientific ideals, but no murmur of complaint escaped him. The long service of thirty-three years to Harvard University was unremitting; for he never claimed the occasional holiday-year which was his due.

On September 2, 1871, he was married to Miss Ellen Grace Shepard, who with their son, Edward Burlingame Hill, survives him. In recent years their summers have been spent in Dublin, New Hampshire, and bicycle rides thence to Cambridge on laboratory business were not unusual occurrences during the summer months.

The National Academy of Sciences elected Professor Hill to membership as

long ago as 1883, and he was also a fellow of the American Academy of Arts and Sciences and a member of the Washington Academy and of the American and German Chemical Societies.

Professor Hill's original scientific work was marked by the quality which pre-eminently characterized his whole life—absolute sincerity. At the outset, great enthusiasm enabled him soon to overcome the handicap of his somewhat inadequate training, and even his first paper on methyluric acid was an unusually thorough and convincing piece of work. Soon afterwards his fortunate discovery of the rare substance furfural among the products of the dry distillation of wood, enabled him to begin its investigation; and for twenty years his best thought was given to the derivatives of this substance, especially to pyromucic, mucobromic and mucochloric acids. This series of investigations constitutes a remarkably complete and systematic whole, raising a large group of substances from a position of oblivion to one of commanding importance. Later his discovery of nitromalonic aldehyde led him to a number of interesting syntheses of the benzol ring; and last winter he was engaged in the study of derivatives of pyrazol, another ring-structure.

An acute sense of the responsibility of publication was always in his mind; accordingly his words were carefully weighed, and unusually free from misstatements. Work done by students was always repeated with his own hands before publication—instead of being tested only here and there, after the manner of most chemists. His remarkable lectures on organic chemistry were noticeable for the same admirable completeness; they presented a finely balanced and comprehensive view of the subject. In these lectures he occasionally expressed theoretical views of his own

which never appeared in print. Many of these views have since been generally adopted at the later independent suggestion of others less diffident about publication. An example in point is his opinion concerning the structure of diazo bodies, first conceived by him over twenty years ago, and now conceded to be the most probable hypothesis.

Hill's original work and his lectures were equally conspicuous for thorough knowledge, convincing logic and perfect sincerity. Until the end his highly cultivated and widely varied tastes continued to be sources of refreshment and pleasure to him, while to those of his colleagues who came closest he revealed also keen and appreciative sympathy, self-forgetting generosity, a staunch and devoted friendship, undaunted courage, and above all, single-heartedness in the search for truth.

T. W. R.

THE STATUS OF PUBLIC MUSEUMS IN THE UNITED STATES.

I. THE AUSPICES OF OUR MUSEUMS.

No general discussion of the status of our museums has been attempted, although G. Brown Goode (see 'Annual Report of Smithsonian Institution,' 1897, Vol. II, U. S. National Museum) has presented many phases of the subject in a masterly manner in his papers upon 'The Genesis of the United States National Museum,' 'The Origin of the National Scientific and Educational Institutions of the United States,' 'The Beginnings of American Science,' etc. He also instituted some comparisons between our museums and those of Europe, and in his report upon the condition and progress of the U. S. National Museum, 1892-93, he shows that while for 24 years the South Kensington Museum had spent an annual average of about \$47,000 in the purchase of speci-

mens, our National Museum had never spent more than \$8,500 annually for this purpose.

It is gratifying to observe that while our National Museum has been enabled to spend annually somewhat more for specimens than during the period referred to by Goode, yet in 1901 the American Museum of Natural History expended more than twice as much as the National Museum for this purpose.

The whole question of museum status has become an important one, as we are in all probability upon the eve of a museum movement which may prove comparable with the great increase in efficiency and number of our public and school libraries, which during the five years from 1895 to 1900 have increased from 4,026 to 5,383, and the number of volumes from 33,051,872 to 44,591,851, or almost 35 per cent.

No corresponding increase has taken place in the number of our public museums or in the magnitude of their collections; and, indeed, the subject has attracted so little public interest that no published lists of our museums are at present available, although a very valuable list of the natural history museums of the United States and Canada and an account of their collections are being prepared under the direction of Professor Frederick J. H. Merrill, of the New York State Museum, and will soon be published.

Professor Merrill has been so kind as to allow me to inspect the proofsheets of this interesting work, and I am also indebted to the Smithsonian Institution for a partial list of the museums of the United States. It appears that within the United States there are at least 252 institutions which contain collections of objects of natural history. Of the total number, 176 or 70 per cent. are school, college or university museums; 31 are the museums of learned

societies; 29 are under national or state control, such as the museums of the various geological surveys, agricultural and mining bureaus, etc. Sixteen of our museums are not under the control of colleges, learned societies or national or state governments, but either are maintained by private endowment derived from public-spirited citizens, are supported by municipalities, or are under the control of boards of trustees, who administer funds derived both from cities and from private subscription.

It is noteworthy that, although the number of such institutions is as yet small, among them we find some of the greatest and most useful of our museums, such as the American Museum of Natural History, the Field Columbian Museum, the Carnegie Museum at Pittsburgh, etc.

It is both sad and interesting to observe that no society composed primarily of learned men has succeeded in maintaining a thoroughly successful museum, yet forty-five years ago the leading museums of our country were controlled by such societies. It is possible that the government of these societies may have been too democratic to insure that permanency of policy and maintenance of a strong executive which appear to be necessary to insure the success of American institutions of learning.

However, these societies have not advanced in material resources at a rate comparable with that of the country itself, and in consequence are relatively poorer to-day than they were many years ago. Their general lack of success is the more remarkable from the fact that most of them have existed in our wealthiest and most progressive cities, and that while other institutions of learning have received bountiful support from both private and public sources,* the museums of learned societies

have been relatively neglected. In other words, they have generally failed to interest men of wealth who are desirous of devoting a portion of their resources to the advancement of public education.

Experts upon scientific subjects are not usually adepts in matters of finance, and the successful management of a great museum appears to demand that its financial resources and expenditures be under the control of a board of trustees composed of representative men of affairs, while the scientific policies of the institution might well be directed by men of science.

Such, in general, is the scheme of management of some of our best museums, and it would appear that our learned societies must surrender the control of financial matters into the hands of experts in finance before they can hope to achieve their due measure of success in museum management. It is much to be regretted that many of the collections which have furnished the basis for classic memoirs of science, and some of the most valuable scientific libraries in our country, are stored in buildings which are not fire-proof and are inadequate in many ways for the proper care and maintenance of the treasures which they contain.

Turning to the subject of museums under the control of colleges and universities: 176 such institutions are known to maintain collections in the natural sciences, while 44 more small colleges are believed to contain collections. It is safe to say that fully two thirds of these college museums are, as Goode aptly states, 'mere store-houses for the materials of which museums are made.' Our universities, both under private endowments and under state control, are developing good museums, but it \$6,800,000. During the same period the funds of Harvard have increased from a little over \$600,000 to more than \$14,000,000.

* In 1850 the funds of Yale University amounted to about \$300,000. In 1902 they were over

is worthy of note that the most successful of these owe more of their prosperity to the generous interest and financial support of public-spirited individuals than to the college itself.

A good example of this condition is seen in the zoological museum of our oldest university, which, distinguished above all others for its publications of research and for having been the cradle of most of our leading naturalists, has been mainly dependent for many years upon the generous bounty of a single individual. Other examples might be cited, but the above will suffice to show that even our greatest and richest universities have not been able to maintain museums worthy of their aims, unless aided by private subscriptions for the purpose. The financial resources of our universities have been taxed to the utmost in the erection of buildings and employment of leading scholars upon their faculties, and few of them have been able to devote a due measure of support to museums.

Moreover, our universities have often failed to recognize the benefit which the museum may confer upon the institution as a whole as a center for productive scholarship and publication of research.

Unfortunately, at present, museum curators are too often narrow specialists who display little interest in subjects other than those which demand their immediate attention, but the fact remains that the curator enjoys a unique opportunity in that he gains much of his knowledge direct from nature and that in this his opportunities for research and exploration are unrivaled. The organization of graduate schools in our universities is beginning to demand the appointment of professors who shall be productive scholars and leaders of research, and who shall instil into the graduate students that thirst for knowledge and

desire for its advancement which inspires the university students of Germany. The curators of university museums should be men of this stamp.

Too often our college museums are vast storehouses of practically unstudied materials under the charge of men who are already overworked in the prosecution of their duties as teachers of elementary facts, or worse still, under the control of specialists who rarely or never may lecture to the student body, and whose store of valuable knowledge is wasted in seclusion. The university museum should be the center for the intellectual life of the graduate student in the natural sciences. The curators should be his teachers, and the resources of the museum should be constantly expanded to meet his needs, and to encourage research which may lead to the discovery of new laws of science.

It is remarkable that, although large sums have been given within recent years for the construction of buildings and for the purchase of collections in our museums, relatively little has been devoted to the endowment of publications of research.

Our university museums must remain ineffective as centers for the advancement of science until this defect has been overcome.

It appears that museums under purely political or governmental auspices have in our country rarely attained to that success which one might reasonably have expected them to have achieved.

Without in the least reflecting upon the character or abilities of the corps of eminent men of science whose names are inseparably connected with that of our National Museum, and who in the face of limited means and meager opportunities have devoted their lives to its service, it may not be too much to say that this institution should be granted a greater measure of independence, its curators should have

more freedom to devote their energies to the advancement of science, and the museum must receive more effectual rather than greater financial support before it can hope to attain to that exalted position among the world's museums which should be occupied by the National Museum of the United States.

On the whole, it appears that our most successful museums are those in which the financial control is vested in boards of trustees composed of representative, public-spirited men of affairs, who serve without salary and who determine the expenditure of funds derived from both public and private sources. Such boards of trustees should be and usually are dependent upon the advice of scientific men for suggestions concerning the scope, management and educational policy of the museum.

The responsibility incident to the administration of public funds maintains the stability and efficiency of the board, and enables it to secure the services of men of culture, energy and influence, whose connection with the museum becomes an important factor in maintaining public interest and respect for the institution.

II. SCOPE, DISTRIBUTION AND RESOURCES.

From a study of Merrill's 'List of the Natural History Museums of the United States,' *The American Art Annual*, 1900, and other sources of information, it appears that there are within the United States at least 233 museums of natural history, 13 of science and the fine arts, 6 of science and industrial arts, 34 of fine arts, 11 of industrial arts, 20 of history, and 26 which combine art, history, archeology and ethnology in varying proportions. There are thus at least 343 collections in the fields of art, science and history open to the public of the United States.

It is evident that our country is already

rich in incipient museums, for while many of the collections recorded above are mere 'materials out of which museums may be made,' there is reason to expect that a large proportion of them will ultimately develop into creditable museums.

The fact that there appear to be but 17 museums devoted to the industrial arts in the United States is remarkable when we consider the enormous progress which our country has made in this direction. This may possibly be taken as an indication of the general lack of interest in museums which prevailed until within recent years in our country, and this explanation appears more probable when we consider that among our most valuable industrial collections are those in the Patent Office building, which were accumulated not primarily for the purpose of establishing a museum, and that such exhibitions are either insignificant or altogether wanting in our great industrial cities. With the exception of Philadelphia, our industrial cities have not yet awakened to an appreciation of the valuable educational influence which may accrue through the exhibition of carefully selected and clearly labeled models of machinery and apparatus used in the arts and trades, and displays of products in various stages of manufacture.

Certainly the remarkable advance which Germany has achieved in manufacture and in the industrial arts has received substantial aid from her great industrial museums, where these processes may be studied in detail. Our technical schools and colleges should devote more attention to the establishment of well-planned museums, wherein the processes of the arts and the history of inventions may be exhibited.

Although our museums are most deficient in industrial exhibits, they are but little better in their historical dis-

plays. Only 43 museums known to the writer contain historical exhibits, and 84 per cent. of these are in the oldest states. Massachusetts leads with 12 such museums. Pennsylvania has 10, Virginia 4, Washington, D. C., and New York 3 each, while California and Illinois have 2 each. Maine, Maryland, New Jersey, New Mexico, Ohio, Rhode Island and Utah have each one such museum. Nearly all of these museums are under the control of historical societies, most of which receive little or no aid from public grants and, in common with other learned societies in our country, are financially poor and becoming relatively poorer as the country develops. A museum of history maintained at least partially by public funds should be established in each of our leading cities.

Although remarkable progress has been made in the establishment of museums of art in our country within the past ten years, these institutions still exist in surprisingly small numbers even in some of our richest states. Massachusetts has 14, New York and Pennsylvania 12 each, Washington, D. C., 7, California 3, Colorado, Connecticut, Illinois, Maryland, Rhode Island and Virginia have 2 each, while Georgia, Michigan, Missouri, New Mexico, Ohio, Oregon, Utah and Wisconsin each have 1. In addition to these, however, there are 19 general museums which are devoted to both science and art. Eighty per cent. of our art museums are in the states on the Atlantic seaboard. The majority of these institutions are art galleries rather than museums of art. Nowhere is the labeling more imperfect or the arrangement of the exhibits more illogical, from the educational standpoint, than in most of our art museums. Almost no effort is made to give a comprehensive view of the development of art, and the pictures are arranged to produce what is known as

an 'artistic effect' rather than to show the sequence of the various schools or the causes of their rise and decline. We also learn but little of the life histories of the artists, their aims or achievements, and the display is designed to appeal more to the eye than to the mind. It is not the purpose of this article to criticise, but to indicate what might be done in the future. No department of museum activity can exert a more immediately refining influence upon the people or lead more surely and rapidly to a higher development of public appreciation of the beautiful, than that of art. The contrast between the architecture in our American cities and that of those in Europe is sufficient warrant for the conclusion that although great improvements have been made within the past few years, public appreciation is still crude and uneducated in matters of art.

Our oldest, most numerous and, in general, richest museums are those devoted to natural history. These are more uniformly distributed over the country than are museums of other sorts, only 46 per cent. of them being found in the region comprised in the original thirteen states. New York leads with at least 31 such museums, then follow Pennsylvania with 19, Massachusetts 17, Illinois 15, Ohio 14, and California with 10. Not only are the natural history museums of New York and Pennsylvania more numerous than those of Massachusetts, but the annual income of a single natural history museum in New York is much greater than the combined incomes of all such museums in Massachusetts, and the richest museum in Massachusetts has not one third the annual income of the Field Columbian Museum of Chicago.

Although now small and poorly supported financially, a generation ago the natural history museums of Massachusetts

were the most creditable in our country, and while they are still distinguished as having been the fields of labor of some of our greatest naturalists and as having produced research work of high and lasting value to science, yet are they doomed to sink into insignificance in comparison with those of New York, Illinois, Pennsylvania and California unless that public spirit which has ever distinguished Massachusetts be immediately aroused in their behalf.

NUMBER OF MUSEUMS IN EACH STATE.

Name of State.	Natural History.	Art, History, Industries, Etc.	Total.
New York.....	31	13	44
Pennsylvania.....	19	18	37
Massachusetts.....	17	20	37
Illinois.....	15	3	18
California.....	10	5	15
Ohio.....	14	1	15
District of Columbia.....	6	8	14
Virginia.....	4	5	9
Colorado.....	6	2	8
Kansas.....	8	0	8
Maryland.....	5	3	8
Wisconsin.....	7	1	8
Connecticut.....	5	2	7
Iowa.....	7	0	7
Missouri.....	6	1	7
Rhode Island.....	4	3	7
Indiana, Minnesota, Tennessee.	5	0	5
Georgia, Maine, Michigan....	4	1	5
Kentucky, South Carolina, Vermont, Washington.....	4	0	4
New Jersey.....	3	1	4
Alabama, Mississippi, Nebraska, New Hampshire, South Dakota, Texas.....	3	0	3
Oregon.....	2	1	3
Florida, Hawaii, Louisiana, North Carolina, North Dakota, Utah.....	2	0	2
New Mexico.....	1	1	2
Arizona, Arkansas, Delaware, Idaho, Indian Territory, Montana, Oklahoma, West Virginia, Wyoming.....	1	0	1

Within recent years Boston has acquired what is probably the most extensive and well-planned system of public parks in our country, but it must be stated, to her dis-

credit, that she gives nothing to the support of her museums, all of which are struggling against undeserved poverty. In this respect she is more conservative than New York, Philadelphia or Chicago; and even small cities of Massachusetts display a more enlightened policy than Boston.*

The accompanying table gives the geographical distribution of our museums.

RESOURCES AND EXPENDITURE OF OUR MUSEUMS.

No general consideration of museum economy in the United States has hitherto been attempted. Believing that some interesting results might be derived from such a study, an examination was made of the latest treasurers' reports of sixteen of our leading museums, such as the National Museum, American Museum of Natural History, Metropolitan Museum of Art, Field Columbian Museum, Pennsylvania Museum and School of Industrial Art, Free Museum of Science and Art of the University of Pennsylvania, The Museum and Library of the Art Institute of Chicago, Carnegie Museum of Natural History, Museum of Comparative Zoology at Harvard College, Museum of the Boston Society of Natural History, Cincinnati Museum Association, Peabody Museum of Archeology in Cambridge, Detroit Art Museum, and three other institutions which are under political auspices and whose employees are controlled by civil service rules. The total annual income of these museums amounted to \$1,418,144, of which \$723,583 was derived from public grants, while \$694,561 was obtained from private sources consisting of gifts, subscriptions, interest on endowment and admission fees. This amount does not include balances on hand at the beginning of the year or the proceeds of sales of speci-

* In 1901-02 the city of Springfield, Massachusetts, appropriated \$29,945 for the maintenance of its museums and library.

mens or catalogues, but represents the voluntary contribution of individuals to the direct support of the museum.

These museums expended \$725,116 for salaries and wages, from which we see that the public support which they received was not quite sufficient to meet this item alone, the entire expense for maintenance, purchase of specimens, cost of expeditions, libraries and publications being, so to speak, borne by voluntary subscription of private individuals.

It is possible to discover the amounts paid for specimens in the case of thirteen of these museums; the total sum being \$80,828, or less than twice the sum an-

4.9 per cent. for expeditions, 5.7 per cent. for publication of researches and 1 per cent. for books, pamphlets and binding; leaving 31.3 per cent. for maintenance, repairs, cases, installation of collections, etc.

The museums under political auspices, whose employees serve under civil service rules, show poor economy in their management in comparison with that of museums whose finances are managed by boards of trustees not subjected to political influences, and who have full control over the administration of public or private funds, with power to appoint and discharge all museum employees under rules of their own making.

Name of Museum.	Year Ending	Total Per cent. Paid for Salaries and Wages.	Per cent. Paid for Salaries of Scientific Staff and Preparators.	Per cent. Paid for Salaries of Clerical Staff, Laborers and Guards.	Per cent. Paid for Specimens.	Per cent. Paid for Expeditions.	Per cent. Paid for Books, Pamphlets and Binding.	Per cent. Paid for Publication of Researches.
National Museum.....	June 30, 1901.	66	24	42	4.6		0.7	4.7
American Museum of Natural History.....	Dec. 31, 1901.	45			10.2	9.6	0.6	5.4
Field Columbian Museum	Sept. 30, 1901.	53	31	Janitors, guards, labor, 22.	6.9	7.4	0.4	2.5
Carnegie Museum of Natural History	March 31, 1902.	52			13.6	8.2	2.2	5.1

nally expended by the Kensington Museum for this purpose. Eight of the museums maintained expeditions for collection or research, and these cost in the aggregate \$48,544. Nine institutions expended a total of \$58,118 in the publication of researches, and twelve expended a total sum of \$13,895 for books, pamphlets and binding. In other words, in these sixteen museums we find that 51 per cent. of their income came from public grants, and 49 per cent. from private sources, while 51 per cent. of their total income was expended in salaries and wages. Where the amounts are known, an average of 6.1 per cent. of their income was expended for specimens,

For example, the four institutions under civil service rules expended from 45 per cent. to 75 per cent. of their incomes in the payment of salaries and wages, the average being 63.7 per cent.; whereas the twelve museums not under civil service regulations expend from 25 per cent. to 66 per cent. in salaries and wages, the average being 45 per cent. or 18.7 per cent. lower than that of the institutions under the civil service.

A fair example of the general lack of economy of civil service administration in our museums is illustrated by a comparison of the expenditure of our National Museum with that of three non-political institutions,

such as the American Museum of Natural History, the Field Columbian Museum and the Carnegie Museum of Natural History in Pittsburgh.

This comparison appears fair, owing to the fact that the management of our National Museum is more economical than that of many other prominent museums under political auspices.* The results are presented in the table on previous page showing the percentage of total income devoted to various purposes.

In general, it appears that museums under political control expend more for salaries and wages and less for specimens than do those whose management is entrusted to boards of trustees who have power to appoint and discharge employees independent of civil service rules. Museums under civil service rules, however, expend relatively more for books and pamphlets, and more for the publication of research, than do public museums not under political control.

The museums of universities or of learned societies, however, lead in the proportionate amount devoted to the development of their libraries and to publication of original research, and these institutions have in our country contributed to the advancement of science and education in a ratio wholly disproportionate to their relatively meager income.

An analysis of the expenditures for salaries and wages in our museums under civil service shows that in general they pay much more for the services of clerks, guards and laborers than for the salaries of

men of science, artists and skilled preparators, while the reverse is the case in museums under other auspices. The museums of colleges are most economical in their appropriation for salaries, but in many such museums the lack of curatorial work upon the collections is very apparent, and renders their educational value insignificant in comparison with that of collections which have received more attention in labeling and arrangement. Also the universities often rely, to a considerable extent, upon the services of unpaid curators, who devote only a portion of their time to museum work and whose spasmodic efforts are, on the whole, unsatisfactory.

As Sir William Flower* aptly states: "What a museum really depends upon for its success and usefulness is not its building, not its cases, not even its specimens, but its curator. He and his staff are the life and soul of the institution, upon whom its whole value depends."

Specimens are materials only; their usefulness depends upon what is done with them. Our museums can do no better than to obtain the services of men of the best scientific training and efficiency. We require better rather than more men. Museums from their nature afford exceptional opportunities for study, research and exploration, and may be made peculiarly attractive as fields of labor for men of science who desire to increase knowledge. The leading men of science in our country should be found in the museums, but a narrow policy in the granting of opportunity for research, exploration and publication, and the general poverty of our museums, have confined them largely to our universities, where their efforts are devoted to elementary teaching rather

* The National Museum being the repository for all collections made under the direction of government, is not obliged to maintain expeditions under its own auspices. The sum of \$2,016, or 0.7 per cent. of its total income, was devoted to 'travel.'

* 'Essays on Museums and Other Subjects Connected with Natural History,' London, 1898, p. 12.

than to productive scholarship,* and this condition will hardly improve until our universities can afford to appoint professors who shall lecture exclusively to the students of the graduate school.

As a whole, our museums expend too small a proportion of their resources upon the development of their more serious aims, such as the maintenance of learned libraries, the publication of research and encouragement of exploration. The great majority of our museums contribute little or nothing to the direct advancement of knowledge, either in publication of original work, or in the maintenance of lecture courses given by acknowledged masters. Moreover, the installation, arrangement and labeling of their collections, and economy in expenditure leave much to be desired. It is true that all of these deficiencies are in a measure traceable to the poor support which our museums receive from public funds, a fact which is apparent when we consider that the British Museum in 1897-98 received a public grant of about \$812,000 or more than the entire public support given more recently to sixteen of our best museums whose finances we have been considering.

In European countries the state of civilization and development of culture of each nation is certainly commensurable with the development of its museums. Measured by this standard, the United States compares unfavorably with other civilized countries.

This investigation appears to show that the average well-managed museum in the United States devotes one half of its annual income to salaries and wages, one

* An excellent exposition of the inefficiency of our universities as centers for the production of research is given by Hugo Münsterberg, 'American Traits from the Point of View of a German,' Chapter III., 'Scholarship,' 1901, Houghton Mifflin and Co.

third to maintenance, installation and repairs, and only about one sixth of its income to expeditions, library, publications of research and purchase of specimens.

ALFRED GOLDSBOROUGH MAYER.

MUSEUM OF THE BROOKLYN
INSTITUTE OF ARTS AND SCIENCES.

*MONTANA AS A FIELD FOR AN ACADEMY OF SCIENCES, ARTS AND LETTERS.**

It seems appropriate at this meeting, the first in the history of the work of the Montana Academy of Sciences, Arts and Letters, to discuss the opportunities for work in the state, rather than to take the discussion of some problem or phase of work, tempting as the latter may be. In this day of many societies and organizations, when each line of work has its own organization, with a membership composed of those directly interested in the work fostered by the organization, it would appear that new organizations and societies should not be brought into existence without good reasons for so doing. Let us present some of the reasons for the organization of this academy.

In organization lies strength. According to the laws of physics, if a thousand separate forces act upon an object from different directions the object will move in the direction of the component of all the forces and with the force exerted by it. This component may be smaller than any single force, when the forces act against each other. Or it may be the sum of all of them when they act together. Each human being may be considered to represent a force. The sum total of progress represents the combined action of all the forces of the different units, human beings. When the work is concerted and not antagonistic, progress is rapid. When every

* Address delivered at the first meeting of the Montana Academy of Sciences, Arts and Letters, at Bozeman, Montana, December 29, 1902.

man is at war with his neighbor advancement is slow.

The strength of organization has long been recognized. The political 'machine' may not number many politicians, but its power is well known. Church organizations have for centuries been powerful agencies among men, controlling both thought and action. Capitalists organize, making many monopolies into one gigantic monopoly, and threatening the peace of the world. Nations form alliances for protection. Laborers unite as a unit to bring about reforms and better to protect themselves from abuses of employers. The wave of organization is sweeping onward with great force. Nothing to-day promises success without organization and concerted action. Proof of this is the great number of societies of various kinds, with titles expressive of their importance and work.

This banding together of human beings for mutual good is usually of two grades or degrees, *i. e.*, local and state or national. Local associations deal with affairs immediately at hand. State and national societies discuss subjects broader and more far-reaching in scope, omitting such details as refer to single localities. There is thus a double tie of strength in organization. The strength of the national or state society is measured in great part by the strength of the local associations. Each aids and supports the other.

If the foregoing is sound reasoning there is much to be expected from such an organization in the state as that proposed in the Academy of Sciences, Arts and Letters. The teachers of the state have their state association, with its various departments. With this we do not wish to interfere. The agriculturists, wool-growers, cattlemen, horticulturists, laborers of various callings, physicians and others have their local and state organizations or both, in

order the more effectually to accomplish the work the individual members see should be done. By such an association an individual idea soon becomes common property. The good things are quickly sifted and are pressed by the power of the whole association instead of by the individual who first conceives them.

Most of the great achievements of the world have come about through exchange of ideas. The occasional meetings of kindred spirits for the discussion of topics in which there is mutual interest are productive of far more good and are much more effective than is usually considered. At such gatherings there is an unusual stimulus for thought. Business or professional cares are subordinated to the work of the association, and the thought and attention are directed solely to the subjects presented. A single suggestion from some paper may start a flow of ideas which may develop into work of vast importance. Often it happens that at such gatherings are found men and women so full of suggestive ideas that it is impossible for one person to operate them all. Those less fertile in originality may receive suggestions which otherwise could not possibly be obtained. This exchange of ideas is all important in such gatherings as this, and its value can not be over-estimated.

We can not live without friends. If we were cut aloof from the aid and companionship of our fellows life would be profitless. It is give and take. Some give more than they take, others take more than they give. It is certainly true that the wider one's circle of friends and acquaintances becomes the greater is the opportunity for giving and receiving ideas and suggestions, hence of receiving help and becoming a helper. Occasional fraternal gatherings widen one's circle of friends, bind closer the bonds of unity in work,

give new inspiration for work and added stimulus for greater effort.

Everywhere among educational men is heard the urgent call for investigation. Trained investigators are sought on every side. Investigation is demanded of college professors by governing boards. It is inspired in students. The investigators make the world move. They are the leaven that moves society to demand social reforms. They open new fields for commerce. Educational reforms are suggested by them. To them we look for the alleviation of diseases, for the control of pestilences. If the fabled fountain of immortal youth is ever found it will surely be through the efforts of this noble class of men. They have practically banished the curse of yellow fever in the tropics; by their efforts the Oriental fruits are grown on the opposite side of the earth; electricity has by leaps and bounds, at their magic touch, entered almost every occupation of civilized man; by their unflagging efforts the unwritten history of past ages has become common property; space has been annihilated by their inventions; the farmer, the fruit-grower, the merchant, the lawyer, the laborer, all must acknowledge the powerful influence exerted by the investigators.

Division of labor is being differentiated very rapidly during the last decade. The pressure for specialization in occupations and professions is fast driving men into one single phase of a subject for an occupation. This differentiation of occupations and division of labor will become more and more circumscribed and complex as the years go by. Each new discovery and invention multiplies the possibilities of increased work ten, twenty or a hundredfold. The specialist who by continued investigation adds new ideas and new inventions to the world's large

list benefits the race by so doing, and adds luster to his name and nation. But at the same time he draws more sharply the line that marks the life work of his successors. His work is demanded. It indicates the highest degree of mental activity. It demands a fertile brain, a vivid imagination, a philosophical mind, a benevolent and humanitarian nature.

It is not to be expected that every investigator in the state should be a member of the academy, but certainly every member of the academy should be an investigator. Each person should have some one idea, or several ideas, which may demand original work, whether it be in the field of science, arts or letters. The meetings of the academy should be given up almost entirely to reports of work in progress. They should be the means of making public the work of investigation carried on by the members, and no paper should be considered too technical for presentation.

The object of the Academy is stated in Article II. of the constitution.

"The object of the academy shall be the promotion of sciences, arts and letters in the state of Montana. Among the special objects shall be the publication of the results of investigation, the formation of a library, and the promotion of a thorough scientific survey of the state."

This is a broad and liberal field for action. It may be appropriate here briefly to summarize some of the opportunities presented to the members of the academy in the state of Montana.

The state contains approximately 146,000 square miles of territory. About one third of this is agricultural land, either in cultivation or capable of being cultivated by the use of water; one third is grazing land, either too remote from water for irrigation or too uneven to permit the use of water; the remaining third is mountainous.

The state is almost three times the size of either Iowa, Wisconsin, Arkansas, Alabama, North Carolina, New York, Mississippi or Louisiana; it is 140 times the size of Rhode Island, 75 times as large as Delaware, 30 times the size of Connecticut, 20 times the size of New Jersey, 18 times the size of Massachusetts, 16 times that of Vermont, $14\frac{1}{2}$ times that of Maryland, 6 times that of West Virginia and almost five times the size of Maine. Its area equals the combined areas of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New Jersey, Delaware, Maryland and West Virginia; or of Nevada with Pennsylvania thrown in; or of Virginia, West Virginia, Ohio and Kentucky. It is about 600 miles from the eastern to the western end of the state, 722 by the Northern Pacific Railroad.

The climate varies from the moist and heavily timbered belt in the west to the dry arid plains in the east; from the cold northern boundary to the mild western and southern area, with boreal regions along the mountain chains.

The scenery of the mountainous regions is sublime. Numerous lakes, flanked by towering mountains, tempt the artist who is skillful with the brush. Broad valleys with winding streams alternate with mountain ranges with untold agricultural, mineral and lumber wealth.

The hardy pioneer, the vanishing red-man, the scenic beauty of the state, the undeveloped natural history resources and the remarkable geological beds offer a rich field for the novelist, the ethnologist, the historian or the scientist. The number to undertake the work is small. The field is large. There is a wide range for selection. Within a decade the work will be much more circumscribed. It should be a part of the mission of the academy to call the attention of the people of the state

and of the world at large to the marvelous resources of the state, and to aid in their development.

Permit me to suggest a few ways in which the academy may be of value in the state.

One of the most necessary lines of work to be accomplished, and in time the first to be undertaken, is to discover what is present in the state. It is impossible to begin work without knowing what the work is about. To determine the distribution of shells necessitates the preliminary work of collecting and identifying species. To discuss vertical range of vegetation on mountains or horizontal range on the plains demands a large amount of hard work in digging, drying, transporting, and mounting numerous collections of specimens, as also their identification.

In this connection it may be stated that there are many important localities in the state to which the collector has not yet made a visit. It may, therefore, reasonably be expected that many of the first scientific papers in natural history and geology will be lists of collected material from limited localities. These are specially desirable and are of prime importance. In geology we may reasonably expect descriptions of mountains showing special structure, discussions of river and lake beds, reports on rocks and minerals, with lists and descriptions of new fossils. We may certainly expect from time to time that those gifted in photography may present slides illustrating the natural scenery, and it is certainly in reason to expect from time to time exhibits of work with the brush, whether they be of topography or natural history matters little.

The academy should pick up the younger individuals and put them to work. It is to them we must look for recruits. They need help. There are in every locality

many persons who are anxious to carry on some work involving original study. It should be fostered in every individual. There are few people who do not in early life have a love for nature. Unfortunately for the large number, this natural tendency to inquire into nature's secrets is smothered by the many other forms of mental activity in which they must engage. This natural tendency, if properly directed and stimulated, may be the beginning of more important studies in science, or art. Our state is young. It is no discredit to say the work of science and art within its borders is not extensive, indeed, is small. But the opportunity is here and all that is necessary is to mass the forces, bring in all those with a desire for work and give them encouragement, and work to a common end.

The academy should seek avenues for advertising the scientific, artistic and literary opportunities presented by the state. There should be no selfish motives in any work undertaken. With a state as large as this there is abundant room for a large number of skilled workers. What the state needs is men of money and men of brains. The former for the establishment of those industries necessary to develop the state, the latter to seek out new lines of development. Tens of thousands might come in, and still the field would scarcely be touched. This end may be accomplished by articles in the daily and weekly press. Rarely is an intelligent article relative to the state refused by the brethren of the newspaper fraternity. Those more gifted may prepare articles for the more pretentious magazines. Pictures of local artists should be purchased and, if possible, distributed. Books and magazines should be purchased. It is not a very encouraging sign to see so excellent a local publication as the *Rocky Mountain Magazine* die for

lack of support. There are many ways in which the state may be advertised, and each individual must use his own judgment as to the best means at his disposal.

The academy should devise means for disseminating the knowledge presented by members at the regular meetings in the papers and discussions.

The earlier history of the California academy is worth recording. During its first years it commanded but little attention. Record of its business and abstracts of papers were given to the public through the medium of the daily press. Now the academy is one of the strongest in the United States, and its publications are of a high order and quite numerous. The publications of the Montana Academy should be issued by the state as state documents. The means of the academy will be limited for some years. If the state's material resources are developed by members of the academy the people of the state should be willing to bear their proportion of the expense, since the work of investigation is gratuitous. If papers in pure science, arts or letters are presented, these should be printed on the ground that all such work is for the advancement of human knowledge. The work of the one preparing the paper is much greater than that necessitated by each taxpayer for its dissemination. The distinction between the practical and theoretical can not be drawn. The theoretical often becomes practical, and neither can do without the other. All papers of importance, therefore, should be printed. With proper safeguards, the publication of the transactions of the academy should be an honor to the state and of great value to its citizens. I suggest that this academy recommend to the legislature the enactment of a law for the printing of the transactions of the academy as state documents.

The academy should foster the organization of a state geological and natural history survey. There is no reason why such a survey should not be begun in the state at an early date. The state is in a prosperous condition. Its prosperity is increasing annually. The portion of the state covered by the United States Geological Survey is very small and does not include much of the work which a state survey would no doubt cover. The work of the state survey should, so far as possible, be carried on conjointly with that of the United States survey. The expense at first need not be great. With a moderate beginning, increased annually as the state prospers, the survey could do a very great service in working out the resources of the state. No doubt but that much of the preliminary work could be done without salaried men and with nothing more than the payment of field expenses by the state. The results of the field workers should be printed as state documents. The survey should be under a governing board free from politics, consisting of men representing the various state institutions, the state scientific organizations and the governor. Every member of the academy should use his influence to have such a survey inaugurated. If the question is properly agitated the survey is likely to be organized.

The academy should aid in the protection of those relics of the past which are of common value and interest to the people of the state. I refer to the preservation of the forests, fish and game, and of historic places and objects. The sentiment for game and fish protection in the state is small. I make this statement after careful deliberation and several years of close study of the question. There is a *desire* for game protection, but little *sentiment*. The minimum penalty is usually imposed

on the offender, and not infrequently the penalty is less than the amount specified by law. The members of the academy should be radiating centers from which sentiment emanates for game and fish protection. They should have a keen eye open for the senseless persons who ruthlessly slaughter song birds in the vicinity of cities or towns. There are in the state many places of historic interest. The members of the academy should be on the alert for such and should use diligent effort to have them preserved. Historic relics grow more valuable with age.

There is need for the academy to lend some assistance toward getting more and better work done in the sciences in the schools of the state. The natural and physical sciences are more inadequately presented in the high schools of the state than other subjects. The condition is much better than it was a few years ago, due in large measure to the adoption of a state course of study, in which a year of chemistry was first required and later a year of biology. The natural growth of cities has demanded better facilities and more extended curricula, another factor in the development. But there is much room yet for improvement. I do not know of a school in the state that has manual training as a part of its work.* Drawing is not required in the high school. The laboratories are confined chiefly to chemistry and physics, although microscopes are being added in several places. The members of this association should lend their influence in the different cities to having better scientific equipment, to the introduction of manual training and to the employment of teachers specially fitted for special work, after the most approved scientific and pedagogical methods.

* Since writing the above I am informed that manual training has been introduced into the Glendive schools.

Each member of the academy should engage in some work which promises fruitful results, and which will in a measure bring recognition for the work. No individual should be satisfied in his present condition. Each person should strive to add something to the world's store of knowledge.

If an organism should cease to make effort when the fatigue point is reached, there could be little advancement in power or progress. If the inhabitants of the world should cease to press in search of the unknown, progress would cease. We can not remain in a fixed condition. We must press forward or fall backward. The masses of mankind are carried forward by the efforts of the few. The greatest triumphs of the century soon become the common property of the people. With the rapid increase of knowledge and the present great differentiation of labor one must seek a limited field and drive some subject hard and increasingly. Membership in this academy indicates a desire to carry on progressive work. The coming annual meetings will give the results of the individual efforts.

In this brief sketch I have but hinted at some of the reasons for the existence of this organization, and have suggested some of the ways in which, as it appears to me, the academy may do good in the state. There are many others yet unrecounted. But if I have encouraged the members to greater individual effort and have led them to feel they are not alone, although a hundred miles from those in sympathy with the work, I shall be satisfied. Montana is not yet out of touch of pioneers. The old hunter and trapper has almost disappeared. The population is fast becoming stable. The pioneers are now those first to take up the work incident to the development of the educational and

esthetic life of the people. For the accomplishment of this end the Academy of Sciences, Arts and Letters takes its place with other organizations. Its life and work will represent the activity of the members which shall make up the organization. May it have a long and useful life.

MORTON J. ELROD.

UNIVERSITY OF MONTANA.

SCIENTIFIC BOOKS.

A Manual of Zoology. By RICHARD HERTWIG. From the fifth German edition. Translated and edited by J. S. KINGSLEY. New York, Henry Holt & Co. 1902. 8vo. Pp. 704.

An English translation of the whole of this valuable manual has been needed, though we had from Dr. Field a good translation of the first or general part. Professor Kingsley has now added a translation of the second, the whole volume well rounding out the series of superior text-books of zoology now at the service of the student and teacher. With two such text-books as Parker and Haswell's 'Zoology,' and the one before us, the zoologist of the present day is fortunate.

Although we are not sure but that, for the student or beginner, the general principles of modern zoology should follow the description of the types or of the principal groups, it is safe to say that the student will nowhere find such a valuable, concise, comprehensive and reliable statement of the general subject as in this volume. It comprises not only a history of the science in nearly all its phases, but the philosophy of zoology, a subject now very much needed for students who are perhaps too early led to specialize. One might wish that the matter of geographical distribution could have been edited with reference to that of North and South America, and that more space could have been given to ecology or bionomics. But the subject covers so broad a field, and on the whole is treated in so equable a manner, that this may seem a superfluous criticism.

In the history of the evolution theory the statement is made that 'Lamarck, in accordance with the then prevailing conceptions,

regarded the animal kingdom as a single series grading from the lowest primitive animal up to man.' This is a mistake. Hertwig could never have carefully read what Lamarck did say, or have known that he was the first to throw aside a serial arrangement and to sketch out a two-branched genealogical tree of the animal kingdom as he knew it. Lamarck, on the contrary, says, referring to the existing animals: 'I claim that they form a branched series,' etc.

The translation uses the word 'rudimental' for vestigial. On page 180, in enumerating the classes represented in the Cambrian period, the brachiopods are omitted, and only six classes in all are enumerated, whereas there are the remains of the representatives of thirteen or fourteen.

The portion on 'Special or Systematic Zoology' is a very useful summary of the characters of the phyla, classes and orders, and in some cases of the suborders and families. Of course, in the matter of classification zoologists even now differ very much. While in the first edition of the original work (1892) the animal kingdom is divided into only seven phyla, there are in the present translation ten. Professor Kingsley has made important changes from the German edition in the classification of the arthropods. He has done well to assign the sponges to a separate phylum (Porifera). The Mollusca are made to precede the Arthropoda. We are unable to follow the translator in placing the Trilobita among the Crustacea, and in separating the Gigantostomata (why not Merostomata, which has the priority by many years?) from the Trilobita. On the other hand, the Merostomata are not included in the Arachnida as is done by some English zoologists. For Trilobitæ Trilobita is preferable, as it is the original spelling of McLeay in 1840. Trilobitæ is the term given by a later author.

The Myriopoda are very judiciously treated, and we quite agree with Professor Kingsley in breaking up the old group Myriopoda into two groups, placing the Diplopoda, with the 'Pauropida' (*sic*) apart from the Chilopoda. With the classification of the insects we should

have some fault to find; certainly the Rhynchota should not be placed in so high a position between the Hymenoptera and Diptera. The Lepidoptera are divided into six suborders, a singular arrangement allowed to remain over from the German text, without change. More modern views might have been adopted in the translation.

A few slips or errors remain to be noticed which could be corrected in a second edition, which we doubt not will soon be called for. Did not Ledermüller speak of 'Infusions-thiere' a little previous to Wrisberg, who called the infusoria 'Animalcula infusoria'? The use here and there of the word 'ringing' for segmentation is not happy. In the too brief account, to be very useful, of *Pithecanthropus* mention is made of 'a molar tooth,' whereas three have been found.

There is a commendable absence of typographical errors. We have only noticed 'trophere,' page 316; 'correllate,' page 389; 'chelefer,' page 450, and 'Pauropida,' on page 497. The copy we have before us is rather faintly printed, and the cuts are not always evenly printed.

A. S. PACKARD.

EUCALYPTS CULTIVATED IN THE UNITED STATES.

BULLETIN 35 of the Bureau of Forestry, U. S. Department of Agriculture, is a handsome volume devoted exclusively to Professor McClatchie's valuable memoir on the 'Eucalypts Cultivated in the United States.' It is profusely and beautifully illustrated, well printed on good paper and every way worthy of all concerned in its production. Above all, it is a timely publication, particularly so when the need of southern California is considered in the matter of fuel. With the extraordinary increase of population in this part of the state follows a corresponding increase in the demand for fuel. The supply furnished by the native trees, red and white oaks, juniper, mesquit, etc., is rapidly diminishing; already the eucalypts, principally *E. robusta* and *E. globulus*, contribute one half or more of the wood fuel. Coal, gas, gasoline and kerosene are largely used; nevertheless, the demand for fire-wood is constantly increasing. Not infrequently the daily papers notice the

planting of new areas in various places, some of large extent; it is very doubtful, however, whether the increase in acreage devoted to the eucalyptus is sufficient to meet the wants of even the immediate future. The present prices are not likely to decline. At \$10 to \$11 for the native woods, per cord of 96 cubic feet (that is to say, three tiers of stove lengths, eight by four feet otherwise) and \$7.50 to \$9 for eucalyptus or gum-wood, as it is popularly called, there is a handsome profit in the cultivation of the latter, for after the first cutting these trees sprout or start again from the stump, and a second cutting can be made in five or six years. The above prices are the retail figures; the discount to the 'wood yards,' is probably not more, on an average, than one dollar per cord, while the retail prices at the 'yards' are much higher than those above stated, for small quantities. The numerous species of these invaluable trees include forms adapted to a great number of purposes in the mechanical arts. It is principally as fuel, shade trees and wind-breaks that they have been used in this country. I have not learned of an instance of their use in the manufacture of lumber. To a limited extent certain species have been used as piles in wharf structures, and it is not unlikely that these may be found to be immune against the ravages of *Chelura* and *Teredo*. The medicinal value of *E. globulus* and other species is above dispute and has been for many years; their use in this direction deserves to be widely extended. The experience of the writer at various times in serious gastric troubles has proved to him their unquestionable medicinal virtues. Again, the bulk of testimony is in their favor when the neutralizing of malarial atmospheric conditions is considered; their beneficial action, or rather the action of certain species, can easily be shown. As Professor McClatchie says: 'The eucalypts probably serve more useful purposes than the trees of any other genus grown on the globe, except possibly the various palms.'

In the professor's memoir some forty or more species are described in a popular way, their characteristics, climatic requirements

and uses given. These forms are illustrated by numerous finely executed half-tone engravings, and otherwise presented in a very useful way by grouping of species according to climatic adaptation and uses. Then follow a 'key' and technical botanical descriptions. The bibliography and index close the volume.

Both the bibliography and the history of *Eucalyptus* culture in California are open to criticism. The highly creditable work of Mr. Elwood Cooper and Mr. Abbot W. Kinney in promoting by precept and practice *Eucalyptus* culture in southern California is justly praised. Of the former, in referring to a lecture delivered by him in Santa Barbara in 1875, it is said: 'This was probably the first address on the subject in America.' By turning to the 'Proceedings' of the California Academy of Sciences it will be seen that on the first day of July, 1872, the writer read a paper, 'On the Economic Value of Certain Australian Forest Trees and their Cultivation in California,' the lecture being printed in full in Volume IV. of the Academy's proceedings, the same is contained in the 'Annual Report of the State Board of Health for 1872,' and about the same date a pamphlet edition of 2,500 copies was published and distributed gratuitously. In connection with this, see also the *New York Nation* for August 22, 1872. Subsequently to the Academy's Proceedings the late Dr. Albert Kellogg contributed a paper on the eucalypts; still later a paper on 'Forest Tree Culture in California' was read before the American Forestry Association at the Cincinnati meeting, April, 1882, and published in the report of that meeting. The late Colonel Warren's *California Farmer*, the first agricultural paper published on the West Coast, contained, first and last, many articles on the foregoing subject. Professor McClatchie's memoir has but little, very little, to say about *Eucalyptus* culture in California north of Tehachapi, or, in other words, latitude 35°; yet north of this general line hundreds of thousands of these trees have been planted throughout a far larger territory, embracing more diversified climatic conditions than southern California.

The extensive plantings made by the Southern Pacific Railroad in the San Joaquin Valley region over twenty years ago and the lessons indicated thereby are not mentioned. General Stratton's forty-five acres in *E. globulus* and *E. viminalis* planted in 1869 in Alameda County, probably the first artificial forest west of the Rocky Mountains, seems to have escaped notice. The late B. B. Redding, for many years land agent of the Central Pacific Railroad, and Professor E. W. Hilgard, of the University of California, and others have written and preached much on the general text.

A useful addition to Professor McClatchie's memoir and one in harmony with its general scope would be a climatic map similar to that published some years ago by the Southern Pacific Railroad Co. In this the thermal zones of the state are exhibited; these zones are governed by topographic features and can not be understood by reference to latitude. One word more as to the propagation of the eucalypts from seed. Judging by my own experience from imported seed, *E. amygdalina* and *E. robusta* germinated as readily as radish or turnip seed, when sown in a cold frame.

ROB'T E. C. STEARNS.

LOS ANGELES,
February 21, 1903.

SCIENTIFIC JOURNALS AND ARTICLES.

THE April number of the *Botanical Gazette* contains two cytological papers. The first is the beginning of an article on 'Oogenesis in *Saprolegnia*,' by Professor Bradley M. Davis, in which he presents newly observed facts regarding the formation of the egg and the behavior of the cenocentrum. The concluding part of the paper will be devoted to theoretical considerations. The second is by Professor David M. Mottier, on the 'Behavior of the Chromosomes in the Spore Mother-cells of Higher Plants and the Homology of the Pollen and the Embryo-sac Mother-cells.' He describes mitoses in the microspore and megaspore mother-cell of typical angiosperms, and homologizes these processes. The occurrence of a single megaspore is regarded as a derived condition, four being the primitive

number. In continuing his notes on North-American grasses, Mr. A. S. Hitchcock describes as a new species *Willkommia texana*. In view of the fact that the concluding paper in Professor F. O. Bower's important series on the 'Morphology of Spore-producing Members' is not likely to be published in full for some months, the editors have published in advance an abstract of the memoir, which contains a general discussion of the results reached in the four previous papers of the series, and of their bearing on a theory of sterilization in the sporophyte. MacDougal's memoir on the 'Influence of Light and Darkness upon Growth and Development of Plants' and Graebner's volume on the 'Heaths of Northern Germany,' are reviewed, together with other current literature. Among 'Notes for Students' Mr. J. Arthur Harris contributes a review of recent teratological literature.

THE May number of the *Biological Bulletin* of the Marine Biological Laboratory contains the following articles:

HELEN DEAN KING: 'The Formation of the Notochord in the Amphibia.'

LEO LOEB: 'On the Coagulation of the Blood of some Arthropods and on the Influence of Pressure and Traction on the Protoplasm of the Blood Cells of Arthropods.'

S. J. HOLMES: 'Phototaxis in Volvox.'

SOCIETIES AND ACADEMIES.

THE SAN FRANCISCO SECTION OF THE AMERICAN MATHEMATICAL SOCIETY.

THE third regular meeting of the San Francisco section of the American Mathematical Society was held at Stanford University on April 25, 1903. Fifteen members of the society were present. Professor Haskell was elected to succeed Professor Wilczynski on the program committee. The following papers were read during the two sessions of the section:

PROFESSOR E. J. WILCZYNSKI: 'Invariants of systems of linear partial differential equations, and the theory of congruences.'

DR. D. N. LEHMER: 'Preliminary report on a table of smallest divisors.'

PROFESSOR H. F. Blichfeldt: 'Note on linear substitution groups of finite order.'

PROFESSOR R. E. Allardice: 'On some curves connected with a system of similar conics through three points.'

DR. SAUL EPSTEEN: 'Necessary and sufficient condition for the existence of invariant subgroups.'

PROFESSOR G. A. MILLER: 'On reciprocal groups.'

DR. H. C. MORENO and PROFESSOR G. A. MILLER: 'On the non-abelian groups in which every subgroup is abelian.'

MR. W. A. MANNING: 'On the class of primitive substitution groups.'

MISS IDA M. SCHOTTENFELS: 'Generational definition of an abstract group simply isomorphic with the simple substitution group G_{30160}^{21} .'

DR. T. M. PUTNAM: 'Certain subgroups of the quaternary linear fractional group of determinant unity, in the general Galois field.'

The paper by Dr. Epstein was presented by Professor Wilczynski. The secretary read the paper by Miss Schottenfels. The other papers were presented by their authors. The next meeting of the section will be held in December at the University of California.

G. A. MILLER,
Secretary.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

At the meeting of the section on May 4, Professor Ernest R. von Nardoff read a paper on 'A New Interferometer Method for Measuring the Refractive Index of a Transparent Plate.'

This method was planned to avoid the use of compensation, which leads to grave errors unless in the compensating material the ratio of the velocities for any two wave-lengths is the same as in the substance being measured. It is frequently impracticable to fulfil this condition, as for example by using as a compensator a second plate of the same material. Air compensation is of course out of the question.

In the present method, in which no use is made of white light fringes, the transparent plate, a microscope cover-glass for instance, is mounted on a special stage perpendicular to the path of one of the beams in a Michelson

interferometer. With sodium light, bands are seen that are generally distorted through lack of perfect parallelism between the surfaces of the plate. The stage is now rotated forward about a vertical axis through an angle of 45° up to a fixed stop, thus increasing the path through plate. Slowly turning the stage backward, the bands passing a fixed point in the field are carefully counted until the plate returns to the perpendicular position, when the motion of the bands reverses. A new count is now made while the stage is turned past the perpendicular, backward 45° to a second fixed stop. Generally these counts differ by a few tenths of a band, owing to imperfect mounting of the stage as a whole on the interferometer, but they may be averaged without sensible error. Since the light passes through the plate twice, one half the number of bands counted should be taken to represent the increase of optical path, N . The thickness, t , of the plate at the part of it observed in the interferometer may be measured by means of a micrometer caliper or a spherometer. The following exact formula, much simplified through the use of precisely 45° of rotation, gives the value of the refractive index, μ .

$$\mu = \frac{\frac{1}{2} + \left(1 - \sqrt{\frac{1}{2} - \frac{N\lambda}{t}}\right)^2}{2 \left(1 - \sqrt{\frac{1}{2} - \frac{N\lambda}{t}}\right)}$$

For sodium light where the wave-length, λ , is 0.0005893 mm.

$$\mu_{Na} = \frac{0.5 + \left(0.2929 - \frac{0.0005893 N}{t}\right)^2}{2 \left(0.2929 - \frac{0.0005893 N}{t}\right)}$$

This method has been extended to the measurement of doubly refracting plates, such as mica. The plate must contain in its plane at least one of the axes of the so-called ellipsoid of elasticity, and must be mounted with this axis vertical. The bands may be observed through a Nicol prism having its shorter diagonal vertical.

A second paper was presented by Dr. G. B. Warring, on 'Some Peculiarities of the

Gyroscope,' in course if which were given some interesting experimental details observed from experiments carried out by Dr. Warring. These experiments are to be performed before the academy, at a future meeting.

S. A. MITCHELL.

COLUMBIA UNIVERSITY GEOLOGICAL JOURNAL CLUB.

April 24.—In reference to some original work Dr. Julien reviewed a paper by August Rosiwal, 'Ueber geometrische Gesteinsanalysen,' from the *Verhandlungen der Kaiserlich-Königlichen Geolog. Reichsanstalt* for 1898.

May 1.—Mr. H. C. Magnus reviewed Bulletin 56 of the New York State Museum. The Bulletin gives many interesting data concerning the 1901 state geologic map. It also gives an excellent review of the geologic surveys of the state, with a table at the end correlating the terms used by the different surveys. Professor Kemp reviewed from the *American Journal of Science*, April, 1903, 'The Mechanics of Igneous Intrusions,' by R. A. Daly.

May 8.—Dr. A. F. Rogers reviewed 'A Three-circle Goniometer,' by G. F. Herbert Smith; Mineralogical Society of London, vol. 12, 1900. Miss Florence Henry reviewed 'The Animal Ecology of the Cold Spring Sand Spit,' by C. B. Davenport. Dr. Geo. I. Finlay reviewed Bulletin 182, U. S. G. S. This bulletin, by F. L. Ransome, treats of the 'Economic Geology of Silverton Quadrangle, Colorado.' Professor Kemp called attention to the 'Geology of the Celebes,' by Professor Bücking, and to Bulletin 213, U. S. G. S., on the economic geology for 1902. This contains the abstracts of some papers not yet issued by the survey.

H. W. SHIMER.

ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

THE 345th regular meeting was held April 14. Professor Friedrich Hirth, of Columbia University, occupied the evening, reading a paper entitled, 'The Early Development of Chinese Civilization.' Professor Hirth exhibited examples of early Chinese art and explained the symbolism and the hieroglyphic characters that are found on ancient works of art and their relation to modern characters. The inception of Chinese culture Professor

Hirth places at the second millennium B. C., noting the unreliability of Chinese written accounts as to the early times. About 120 B. C., Bactrian Greek art influence found its way into China, of which examples were shown consisting of designs on the backs of metal mirrors and of rock carvings. The developments of architecture, writing and printing were traced. Professor Hirth affirms that in art Japan stands entirely on the shoulders of China. The paper was discussed by Messrs. Flint, Spofford and McGee. A vote of thanks of the society was tendered Professor Hirth for his instructive paper.

WALTER HOUGH,
Secretary.

DISCUSSION AND CORRESPONDENCE.

A TROPICAL MARINE LABORATORY FOR RESEARCH.

TO THE EDITOR OF SCIENCE: The subject which Dr. A. G. Mayer has so ably introduced for discussion under the above title is of such importance as to call for careful consideration from biologists. It is also beset with difficulties of a peculiar character, the recognition of which will largely determine its success or otherwise. Of the desirability for such a permanent laboratory and of the great results to biology which would accrue from its establishment there can scarcely be any divergence of opinion. Granted the means for its support the primary discussion will center around the best means for attracting the greatest number of able workers, involved in which is the important question of the most suitable site.

The suggestion for the establishment of a biological laboratory in the tropical Atlantic is by no means new. Ten or more years ago the subject received the public support and encouragement of the late Professor Huxley and Professor Ray Lankester, and was discussed in the English *Times* and various scientific journals, while the Institute of Jamaica has at times made recommendations of a like character.

Three or four years ago a committee of American botanists, composed of Professors D. H. Campbell and D. F. MacDougal, visited

various islands of the West Indies with a view to the selection of a suitable spot for a tropical station. In the end Jamaica was practically determined upon, when the sad death of an American botanist and zoologist in the island resulted in a suspension of the efforts. Within the past two years the Commissioner of the Imperial Agricultural Department for the West Indies, Dr. D. Morris, C.M.G., has endeavored to secure assistance from the Imperial and local governments for the establishment of a marine section to his department, at which biological research could be conducted, but as yet without much encouragement, owing to the depressed financial condition of the islands.

As in so many instances one turns for a ray of hope to the trustees of the Carnegie Institution. But before this beneficent organization can be approached it is manifest that the scheme should be thoroughly discussed and some consensus of opinion reached by biologists as to the most desirable spot. From his personal experience Dr. A. G. Mayer is prepared to support the claims of Tortugas, Florida. A residence for several years in Jamaica is my excuse for the presentation of what I conceive to be the superior advantages of this island, in which I am supported by two of Dr. Mayer's correspondents, Professors E. G. Conklin and T. H. Morgan.

First with regard to the comparative richness of marine life in the different regions of the West Indies. Investigations of the various groups so far conducted (fishes, crustacea, echinoderms, corals, actinians) reveal a great similarity throughout, as would be expected from the uniformity of temperature and the insular conditions of all the likely places. Hence, as regards abundance of life, any area otherwise suitable would be almost equally desirable, except for specific purposes, for the needs of the marine zoologist alone.

A tropical laboratory is much more likely to be a success if from its position it appeals to the worker on land and fresh-water forms as well as marine, to the botanist as well as to the zoologist. And there is no reason why the center chosen should not be as desirable

for the one purpose as the other. It is in this respect, however, that the various islands differ greatly, and where the advantages are altogether in favor of Jamaica. Nowhere in the West Indies is there readily available such a diversity of terrestrial faunal and floral conditions, a fact already recognized by Professors Campbell and MacDougal after an investigation of other islands, and supported by the many American botanists and zoologists visiting there from year to year. The presence of a well-equipped and long-established government botanical department, with all its collecting traditions, is not one of the least of its attractions, as well as known localities for such interesting forms as *Peripatus*. The student concerned with the results of the introduction of new animals and agricultural pests will have his ardor more than satisfied by the mongoose, toad and tick.

In the matter of health the tropics are generally viewed with suspicion. This is well founded as regards investigators who desire to carry on work, involving exposure, in the same manner as in temperate parts, but is of little moment to the resident or experienced visitor aware of the precautions called for under the totally new environment. To select any locality of which the general healthiness or climatic conditions are uncertain, or where proper medical advice and attention are not available, would undoubtedly sooner or later result in a sad collapse.

A central, readily accessible spot, where the general social life and the character of the people will add something to the experience of visitors, is also matter for consideration. The Naples Zoological Station undoubtedly owes some of its success to its geographical position and historic surroundings. A comparatively unknown isolated spot, with no associations beyond those of the laboratory, is not likely to offer sufficient attractions to make a long sea voyage, especially to European colleagues, nor can possibly give that status which a center of activity already recognized can confer. The general social conditions of Jamaica, the hospitality offered from the governor downwards, the experience of English

official, naval and military life are features which have always constituted a charm and attractiveness to the many American biologists who have already experienced them.

Another consideration very important to my mind is the educational value to young biologists—prospective investigators—to be obtained from such an establishment. The broadened conception of the possibilities of the animal and plant world which even a short experience within the tropics affords is very desirable. To wander amid the beauty and luxuriance of life on a coral reef, or pass amongst the intricacies and remarkable adaptations within a tropical forest, gives an inspiration not to be experienced in temperate regions. For this purpose a station having the greatest variety of both land and marine conditions is obviously most desirable. I conceive that many professors will think it worth while to take or send their most promising students, the idea of a general acquaintance with a tropical fauna and flora predominating over that of discovering material for research. For many years such has been the custom of Professor Brooks with regard to his students, and the conditions found in Jamaica have most nearly approached the ideal.

J. E. DUERDEN.

UNIVERSITY OF NORTH CAROLINA.

SHORTER ARTICLES.

THE PHYSICAL BASIS OF COLOR.

At the present time no one, I think, questions the validity of the wave-theory of light. We may hold various views as to the nature, or even the existence, of that omnipresent medium, the ether; and the physicist, though unable to get along without it, is continually changing his conceptions of its manner of action; but the broad general principles upon which the theory is built remain unshaken.

The backbone of the theory is *periodicity*. Innumerable measurements of extreme accuracy have been made whilst experimenting in the various domains of optics, all of which agree in the conclusion that light, in its very essential nature, is *periodic*; and the simplest image one can form in his mind of such a phenomenon is a wave-motion, while the

simplest method of representing it mathematically is by the circular functions of the sine and cosine.

The three quantities which determine a wave-motion are its amplitude, its wave-length (and, therefore, its frequency or period), and the form or contour of the waves. The mechanical measure of the intensity is proportional to the square of the first of these, while the sensation of color is in some way indissolubly connected with the second—possibly, also, with the third, though I do not know of any direct evidence on the question.

It has been usual to assert that color is purely a function of the wave-length, just as pitch is a function of wave-length in acoustics. Light of one wave-length would excite one color, light of another wave-length, a different color, etc. In an article on 'Color Saturation,' which appeared in the *American Journal of Psychology* (Vol. VII., No. 3, April, 1896), my friend and colleague, Professor A. Kirschmann, expresses dissent from the view generally accepted (by physicists, at any rate), and it is the question raised by him that I wish to briefly consider.

Dr. Kirschmann remarks: 'It is claimed that light of one certain wave-length causes the impression of red, another that of green, etc.; but this is mere hypothesis, for *nobody has ever seen light of one wave-length*.' Perhaps it would be fairer to state the proposition as I have done in the preceding paragraph. The physicist surely does not claim that he has ever worked with light of absolutely a single wave-length, though we shall see how near he has been able to approach to it. If a writer on the wave-theory should indulge in such superficial dogmatic statements, he must not be taken too literally, and the true value of the theory must not be judged therefrom.

Dr. Kirschmann supposes a 'pure' spectrum, a meter in length, to be produced on a screen, and discusses the nature of a narrow band of this image $1/100$ of a millimeter in width. Taking the number of vibrations per second, corresponding to extreme red and extreme violet, to be 412 million million and 790 million million, respectively, we see that

the total change of vibration-frequency as we pass from one end of the spectrum to the other is 378 million million. Now, the width of the band under consideration is $1/100,000$ of this distance, and hence in crossing from one side of it to the other there is a change of frequency of approximately 3,780 millions per second. Ordinarily the light from such a narrow band of a 'pure' spectrum would be considered very homogeneous, i. e., of very approximately a single wave-length; but looked at from the point of view of number of vibrations per second, this variation in frequency of 3,780 millions per second, which is to be found amongst the constituents of the light, would at first sight appear so large that we should not be justified in saying that the light from the band is practically of one wave-length. This view is, indeed, held by Dr. Kirschmann, but I hope to show that it is untenable.

Let us look at it in another way. As we pass from the blue to the red end of our spectrum the wave-length increases by an amount equal to itself—by 100 per cent.—this increase being uniform if the spectrum is *normal*. Hence in passing over a band $1/100$ of a millimeter in breadth the wave-length increases by $1/100,000$ part of itself. Thus in the light which comes from this narrow space there is, if we consider the case in absolute mathematical strictness, a superposition of waves of different lengths, but yet the waves are extremely uniform, since the longest is only $1/100,000$ part greater than the shortest. Stated as an absolute length, this difference between the longest and the shortest waves is but one five-thousand-millionth part of an inch.

The size of the number expressing the measure of any quantity depends only on the unit used, and may be quite meaningless when we come to deal with actual sensations. For example, the length of two rods may differ by but the millionth of an inch, a quantity smaller than the error of experiments made to compare them, so that from our physical measurements we should say that the rods were of the same length; and yet if we chose the diameter of a molecule as our unit of

length, the infinitesimal difference between the lengths of the rods would be expressed by millions of millions.

In the light under consideration there is strictly a variation in the wave-lengths, but relatively this is an extremely small quantity—too small to be considered as an essential factor in determining the nature of our sensation. Would it be reasonable to suppose that if there were absolutely no variation at all the effect on the eye would be different? Experiments do not indicate that the eye has such marvelous delicacy that it can detect any such infinitesimal changes.

In a pure spectrum a meter long the widths of the colored bands in the most sensitive portion are given by Rood* as follows:

	Normal Spectrum.	Prismatic Spectrum.
Orange-yellow	26 mm.	20 mm.
Yellow	13	10
Yellow-green and green-yellow...	97	104

Of course it must be understood that these quantities are not absolutely definite magnitudes. They are simply the careful estimate of an accomplished scientist and artist.

An attempt was made to test the sensitiveness of the eye in the following way: By means of a narrow slit and a direct-vision train of prisms in front of an electric arc lamp, a spectrum 80 centimeters long was thrown on an opaque screen, in which was an opening about a centimeter wide and 3 centimeters long. By shifting the screen, light from any desired portion of the spectral image was allowed to come through, and it was then received on a finely ground glass plate. By means of black paper strips the portion of the ground glass thus illuminated was further restricted to two narrow bright bands approximately 1.5 millimeters in width. When working in the yellow it was found that these bands could be separated by a dark strip 1.5 millimeters wide, and still be indistinguishable from each other. A second observer, experienced in optical work, agreed in the above result. Thus the eye was unable to distinguish between the colored bands whose centers were 3 millimeters apart. Now, this distance

* Rood, 'Modern Chromatics,' p. 24.

is $3/800$ or $1/266$ of the total length of the spectrum, and hence, in passing over it, the wave-length varies by approximately $1/266$ of itself, and yet the eye could detect no difference. This certainly seems to indicate that the minute change of $1/100,000$ of the wave-length, above referred to, is not at all able to alter or control the chromatic sensation experienced by the eye. The spectrum used in this experiment was a comparatively pure one, since in the yellow band, one centimeter wide, admitted through the opening in the screen, the bordering colors, orange and green, could clearly be seen at the edges.

But it might be remarked that Dr. Kirschmann's case is a purely hypothetical one, and that my arguments are quite as theoretical, and so it will be interesting to see just how far we have been able to actually go towards obtaining a perfectly monochromatic light.

As is well known, the spectrum given by a grating, with proper adjustments, is normal. The distance between two portions of the spectral image is proportional to the difference of the wave-lengths proper to these portions. Also, the spectrum of a sodium flame (given, for instance, by burning ordinary salt in a Bunsen flame) consists of two bright lines separated by a narrow space. The mean wave-length of the light forming one of these lines is approximately $1/1,000$ greater than that forming the other.

When working with a plane reflexion grating, containing 14,400 lines ruled on a space two inches wide, it was observed that the interval between the two sodium lines was about ten times as wide as either line. Now, as we pass across the interval from one line to the other there is a variation of $1/1,000$ in the wave-length, and hence in passing from one side to the other of a bright line the change in wave-length is *not greater* than $1/10,000$.

But the narrowing of the spectral lines is directly proportional to the total number of rulings on the grating, while the interval between two lines varies directly as the closeness of the rulings; and in some gratings used by Professor Rowland there were as many as 120,000 lines on a space of six inches,

i. e., 20,000 to an inch. Here the rulings are eight times as numerous as in the former case, and so the bright lines of the spectrum should be only one eighth as broad; also, the rulings are three times as close, and so the interval between the sodium lines should be increased threefold. Thus a grating like this should give a spectrum in which the interval between the sodium lines is over 200 times the width of either bright line. If such were the case, we could conclude that the wave-length of the light from each sodium line did not vary as much as 1 in 200,000.

Rowland,* however, remarks that there is a limit to the applicability of this line of reasoning, and that the width of a spectral line given by a grating depends not only on the width of the slit and the number of rulings on the grating, but also on the *true physical width* of the line. But it is quite certain that at least one half the high resolving power above referred to was reached by him in his experiments (*i. e.*, that he really obtained a spectrum in which the width of either sodium line was but $1/100$ of the interval between them), since he reports having actually photographed some lines in which the variation in wave length was not more than $1/80,000$.

But the best test for the homogeneity of any light is to determine what is the greatest difference of path which two portions of it may have and still give interference fringes. With white light this is very small. In the ordinary apparatus for observing Newton's rings only eight or nine rings can be seen with white light, and for the ninth ring the difference of path is about $1/200$ of a millimeter, a very minute quantity. If sodium light be used, many more rings can be seen; and indeed interference has been observed† with it with a difference of path of 200,000 waves, or over ten centimeters.

By using the green line ($\lambda = 5461$), obtained on decomposing by a prism the light

* *Philosophical Magazine*, 5 ser., Vol. 16, p. 209. 1883.

† By A. A. Michelson and E. W. Morley. See address before the American Association for the Advancement of Science, Cleveland meeting, 1888, by A. A. Michelson.

emitted by mercury vapor in a vacuum tube made incandescent by the passage of an electric discharge through it, Perot and Fabry* were able to secure interferences with a path-difference of 43 centimeters; which is equal to 790,000 wave-lengths; while Professor Michelson, of Chicago, who is preeminent in this work, and whose interferometer is the instrument generally used in such researches, informs me that he has obtained interferences, with the light from this same mercury line, when there was a path-difference of 840,000 wave-lengths. In this case the variation in wave-length could hardly have been greater than one part in 1,000,000—truly an extraordinarily close approach to perfect uniformity.

Now, in all these experiments there was no sign of the color disappearing as the wave-lengths approached more and more nearly to equality. Indeed, Professor Michelson's observation is that as the light approaches perfect homogeneity the intensity of the color sensation is slightly increased!

Light of a single wave-length in optics corresponds to sound of an absolutely pure tone in acoustics. A well-made tuning-fork is by no means a perfect instrument, and yet it emits a note closely approximating a pure tone; but such a fork is just as efficient in producing the sensation of sound as the most complex mixture of wave-lengths given forth by any instrument.

Is it possible, then, that these little variations in the wave-lengths, and not the wave-lengths themselves, are the essential physical cause of the sensation of color? Surely it would be just as reasonable to believe that, by removing all the impurities from water, or nitric acid, or any other definite chemical compound, these substances would lose the *taste* characteristic of each.

I think it unreasonable, therefore, to contend that for the production of the sensation of color it is necessary to have a superposition of waves of different lengths. It is quite true that two color sensations which are indistinguishable from each other may be produced in different ways—either by light of approximately uniform wave-length or by a

combination of quite different wave-lengths. For instance, a mixture of red and green will give an orange which, as a sensation, is indistinguishable from spectral orange. In Maxwell's phrase, they are *chromatically* the same, but *optically* they are different. In such matters the eye is much inferior to the ear, which can, in many instances, resolve a compound sound into its constituents; and it would be hard, indeed, to produce a combination of sounds which would so perfectly simulate a simple tone that one could not distinguish between them when they were heard together.

But I can not see why color-quality should not be considered simply as a function of the wave-length. Dr. Kirschmann says: "It may just as well be—and the probability for this supposition is even greater—that the color-quality is a function of the superposition of wave-lengths, so that to every qualitative difference in spectral colors corresponds a difference in the mode of superposition." I think the facts I have given show conclusively that a spectral color is not at all dependent on any 'mode of superposition.' We need no such idea to define spectral colors, and the introduction of it seems a needless complication.

Let us now briefly consider Dr. Kirschmann's 'inverted spectrum,' and his application of the principle of superposition to explain the true position of purple.

When we view through a prism a dark line of the proper width, on a white background, we see a kind of 'inverted spectrum,' with purple in the middle. With Dr. Kirschmann, 'we must agree that the existence of this color does not prove anything more than that the mixture of the ends of the spectrum gives purple.' That is all the experiment appears to me to prove.

If a narrow bright band be viewed through a prism we get a 'pure' spectrum. As we all know, the term 'pure' here has not a very definite meaning. It signifies that certain optical requirements have been complied with; and if we are using sunlight the familiar test for purity is the presence of the Fraunhofer dark lines. If now the bright slit be gradu-

* *Comptes Rendus*, Vol. 128, p. 1223, 1899.

ally widened the colors rapidly lose their pure hues, the change at the central portion being most marked at first. Finally, if the slit be made wide enough, the color entirely disappears from the middle part, while at one end (accepting Dr. Kirschmann's description) there is a band of red, orange and yellow; at the other, one of blue and blue-green. The explanation of this is well known. A wide slit may be considered as the sum of a great number of narrow ones, each of which gives rise to a pure spectrum, but these spectra are superposed, producing perfect white in the middle and the colors mentioned at the ends.

Dr. Kirschmann explains the absence of green proper by saying that its two neighbors, blue and yellow, are here separated, and so are deprived of the power of cooperation, just as in the ordinary spectrum red and blue are separated, and thus can not produce purple. But the nature of the mixture is very different in the two cases, and even though we should grant that the sensation of green is due to the superposition of blue and yellow, we should hardly be justified in concluding that purple should be considered as simple a color as green, since blue and yellow have wave-lengths nearly equal, while the wave-length of red is approximately twice that of blue. We *know*, from physical considerations, that purple is not simple like spectral green.

From the explanation given above it would appear that the 'inverted spectrum' is far from being a pure one, though Dr. Kirschmann thinks that this statement can be proved unfounded. When we examine with a spectroscopy the light reflected from a very thin sheet of mica, we see the spectrum crossed transversely by a number of dark bands. This phenomenon is one of the large interference-family of 'colors of thin plates,' and is ordinarily known as the 'channeled spectrum.' Many investigations have been made on it. Dr. Kirschmann states that he was able to obtain these 'channels' in the 'inverted spectrum.' For the production of such, however, the spectrum need not by any means be pure. In a single experiment with a direct-vision spectroscopy and a sheet of mica about

1/100 of a millimeter thick, I was able to see the 'channels' when the slit was 0.6 millimeter wide, while to show the *most prominent* Fraunhofer dark lines, and thus have a slight approach to purity, the slit had to be less than 0.25 millimeter wide.

To use the channeled spectrum for the purpose of measuring wave-lengths, as suggested, is not very convenient, since the thickness of the thin plate, its index of refraction, the angle of incidence (or of refraction), as well as the 'order' of the interference, would all have to be determined. But if *some* wave-lengths are known, *others* may be conveniently located by this means. A very elegant application of this method was made by Maxwell* in his classical experiments on the mixing of spectral colors. His thin plate was a layer of air between two plane plates of glass, and by the channels in the spectral image shown at the end of his color-box he was able to calibrate in wave-lengths an arbitrary scale put across it.

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SURFACE TENSION; MOLECULAR FORCES.

IN deducing the surface tension equations by the method of Laplace we start with the assumption that the force with which one element, dv , of the liquid attracts another δ element, v , is

$$F = \frac{1}{k} \rho^2 \cdot dv \cdot \delta v \cdot f(r)$$

(usually the k is wrongly omitted), where ρ is the effective density of the liquid, and $f(r)$ is the law of the variation of the force with the distance. Finally we find that the surface tension is

$$T = \frac{1}{k} \rho^2 I,$$

where I is a definite integral (and hence a constant) derived from $f(r)$. In measuring the surface tension of liquids we are usually content to stop when we have found T , or we endeavor to find relations between the values of T for different liquids. We can do much

* *Phil. Trans. of R. S.*, 1860. 'Scientific Papers,' Vol. I., p. 410, § 6.

better than this. The most superficial consideration will show that ρ can not be the ordinary density; but, if what we have designated as molecules have any physical significance whatever, ρ must be proportional to the number of molecules in unit volume. If M is the molecular weight of the liquid, and D is its density, then D/M is the number of gram molecules per unit volume, and we must have

$$\rho = \frac{mD}{M}$$

where m is the factor of proportionality and depends upon the nature of the molecule. Substituting this in the equation for the surface tension we find

however, probably varies from liquid to liquid.

So far we have made no assumption other than those contained in Laplace's equations. Now we shall go farther. If molecular forces are electrical in their origin, as Professor Sutherland and others think, then we are almost justified in putting k equal to the specific inductive capacity of the liquid; and if on replacing k by this quantity we arrive at values for the *molecular moment*, m , all of the same order of magnitude, we can say that the assumption is at least not an improbable one. The following table contains the various quantities involved for twenty substances (all of those for which I have the necessary data at hand), and we see that

Liquid.		k	D	M	T	$\frac{M^2 T}{D^2}$ $= I \frac{m^2}{k}$	$\left[\frac{k M^2 T}{D^2} \right]^{\frac{1}{2}} = \sqrt{I} \cdot m$ molecular moment.
Benzene	C_6H_6	2.3	0.88	78	27.5	216×10^3	0.71×10^3
Toluene	C_7H_8	2.3	0.89	92	27.9	299	0.82
Cymene	$C_{10}H_{14}$	2.3	0.87	134	27.9	660	1.22
Methyl alcohol.....	CH_3O	33.	0.80	32	23.8	38	1.14
Ethyl "	C_2H_5O	26.	0.79	46	23.1	78	1.41
Propyl "	C_3H_7O	23.	0.79	60	24.1	139	1.79
Amyl "	$C_5H_{11}O$	16.	0.83	88	23.8	267	2.06
Acetic acid.....	$C_2H_3O_2$	9.7	1.05	60	29.0	95	0.96
Butyric "	$C_4H_7O_2$	3.0	0.96	88	27.2	228	0.82
Ethyl formate.....	$C_3H_5O_2$	9.1	0.95	74	25.8	156	1.18
" acetate	$C_4H_7O_2$	6.5	0.90	88	25.1	239	1.26
" propionate...	$C_5H_9O_2$	6.0	0.91	102	26.0	328	1.41
" butyrate.....	$C_6H_{11}O_2$	5.3	0.90	116	25.0	416	1.48
Methyl acetate.....	$C_3H_5O_2$	7.8	0.96	74	25.3	150	1.08
Ethyl "	$C_4H_7O_2$	6.5	0.90	88	25.1	239	1.26
Propyl "	$C_5H_9O_2$	6.3	0.91	102	26.2	330	1.45
Ethyl ether.....	$C_4H_{10}O$	4.4	0.79	74	18.2	160	0.84
Carbon bisulphide..	CS_2	1.81	1.29	76	32.3	150	0.52
Water	H_2O	75.	1.00	18	74.	24	1.34
Sulphur.....	S_8	2.8	1.98	192	44.6	430	1.13

$$T = \frac{1}{k} \frac{m^2 D^2}{M^2} I$$

or

$$\frac{M^2 T}{D^2} = I \frac{m^2}{k},$$

a quantity in which the density, which varies from liquid to liquid in a way which can not be predicted, no longer explicitly enters. This quantity $M^2 T/D^2$ is probably very important in molecular mechanics; if k were the same for all liquids it would be *most* important, as it would give us m , which we may call the *mean molecular moment* of the liquid. k ,

$$\left[\frac{k M^2 T}{D^2} \right]^{\frac{1}{2}} (= \sqrt{I} \cdot m)$$

is of the same order in every case, the greatest (2.0) being four times the smallest (0.5), while T varies from 18 to 74, k from 2 to 75, and M from 18 to 256. This appears to me to be as satisfactory an indication of the correctness of this method of viewing the matter as we should expect.

In dealing with similar compounds, very evident relations exist between the different values of $M^2 T/D^2$ and also of $[k M^2 T/D^2]^{\frac{1}{2}}$, but the consideration of these and of other

interesting points will be deferred until I shall have been able to assemble more extensive and newer data.

N. ERNEST DORSEY.

ANNAPOLIS JUNCTION, MARYLAND,

January 31, 1903.

THE OVERSPUN STRING.

LOADING a string by 'overspinning' with wire, as is well known, causes it to produce a deeper tone without adding to its length. It, also, can be strung over a finger-board, where it may be 'stopped,' thus enabling a single string to produce an octave or more with its chromatic intervals, and to take the place of eight or more long open strings. So far as my information goes, the overspun string was introduced into France by St. Colombe about 1675. The chitarrone with its very long open bass strings dates from 1589 and was used in orchestras in 1607. I am desirous of ascertaining whether the superiority of the overspun string over the long open string for the deeper tones was known earlier than I have mentioned, and whether the chitarrone was used because the overspinning was unknown.

E. H. HAWLEY.

U. S. NATIONAL MUSEUM.

NOTES ON THE JUDITH RIVER GROUP.

IN August, 1876, Mr. J. C. Isaac (who had been my assistant earlier in the season in the chalk of Kansas) and myself joined Professor E. D. Cope at Omaha, to go with him as his assistants to the Judith River region in Montana. From Franklin, Idaho, we made the journey of 600 miles to Fort Benton by stage. Here the professor purchased a wagon, four work horses and three saddle ponies, employed a cook (to act also as teamster) and a scout, who was to warn us of danger from Indians. Sitting Bull with his thousands of braves was south of our field, fighting the soldiers. We traveled down the Missouri River opposite Clagett, an Indian trading post, 120 miles below Fort Benton. Here we crossed the river, and went into camp on Dog Creek, a few miles east of the Judith River, and about ten miles from its mouth. The cañon of this creek was narrow. We were shut in by the

dark and desolate Bad-lands, which, as I remember, the professor estimated as over 1,000 feet high. The lower slopes were composed of beds of lignite, from a few inches to six feet in thickness, and black shale, the lignite layers not appearing in the great bed of shale in its upper part. Professor Cope made a sketch of the wonderful panorama, which I afterwards saw published. The shale disintegrated into dust on the surface, into which one sank to his knees in climbing some steep ascent. This formation, Cope assured me, belonged to the Fort Pierre group of the Cretaceous. We found many bones in it, of mosasaurs and fishes, similar to those I had already collected in western Kansas. After my return from Montana I felt sure the black shales then called Niobrara belonged to the Fort Pierre, on account of their faunal and stratigraphical resemblances to those on Dog Creek. It was years, however, before this view was generally accepted. I remember one very good quadrate I picked up on Dog Creek which I thought belonged to a *Platycarpus*. We could have made large collections of these fishes and mosasaurs but for the fact they were poorly preserved and interfered with the main object of the expedition.

On top of the Pierre deposits, which were the thickest, were the buff-colored sandstones of the Fox Hills group. We found no fossils in it, but I was assured by Cope of their position in the series. The Judith River beds, or Cretaceous No. 6, as Cope identified them, were above the Fox Hills. The rocks of this formation were composed of sandstone and clay. On the very highest summits of the Bad-lands was a thin bed of oyster shells. We remained in our camp over a month here. Every morning at sunrise we were in the saddle, taking a lunch of crackers and bacon. We returned late in the evening. Our chief discoveries were from a yellowish sandstone, in which we found many bone-beds, where loose teeth, bones and fragments of turtle shells were mingled together, often weathered out, lying loose on the surface. I have been deeply interested in reading Professor H. F. Osborn's and Mr. L. M. Lambe's 'Contributions to Canadian Paleontology,' Vol. III.,

Part II., Ottawa, 1902. I was especially surprised to see by the table of the distribution of land and fresh-water Cretaceous vertebrates of the west, that many of the species we procured in these bone-beds on Dog Creek, some of which Professor Cope named on the spot, as I distinctly remember, are placed in the Montana column, which on page 9 is placed below the Pierre. I was the original discoverer of the fish *Myledaphus bipartitus* Cope. As I remember, he gave the specific name from the fact that the enamel on one side of the tooth was dark and light-colored on the other. With this species were hundreds of teeth of *Diclonius*, *Dysganus*, *Paleoscincus*, *Aublysodon*, numberless fragments of the beautifully sculptured shells of the turtles *Trionyx* and *Compsemys*, bones of *Campso-saurus*, scales of *Lepidotus*, etc. In the list referred to I am astonished to find the genera *Diclonius* and *Dysganus* not represented in the Judith River column. If I mistake not I discovered the species of *Dysganus* he named in honor of the Peigan Indians on the spot. The four species certainly belong to the Judith River group. These remarks also apply to the three species of *Diclonius*. The new species of *Monoclonius* do not appear in the Judith River column. As they were discovered near Cow Island forty miles below Dog Creek, I will speak of them later. The facts I have here mentioned can readily be substantiated, if collectors will work over the summit of the Bad-lands, east of Dog Creek, as we found inexhaustible deposits of the genera mentioned above, excepting *Monoclonius*, of course all mingled together. As we were unable to discover any good specimens of complete skulls or bones in this region, Professor Cope took his guide and started on an exploring trip down the river. A few days later he sent word to us by his scout to move camp to Cow Island. The astonishing feat we accomplished, of getting our outfit on top of the Bad-lands, over slopes so steep that we had been obliged on horseback to make long angles in order to make the ascents. After fourteen hours of the most strenuous effort human nature is capable of we got to the level prairie. In one place our four-horse wagon with team

attached made three complete somersaults and landed on a ledge of sandstone right side up. The next day, while traveling along between the foothills of the Judith River Mountains, we saw in the distance a horseman approaching, whom we soon recognized as the professor. Before he reached us the scout came out from behind some hill to our south and intercepted him. An exciting conversation took place, judging from their gestures. The scout was the first to come to the wagon. Without a word he took his personal outfit and started toward Fort Benton. The cook followed him until out of our hearing, when they had an earnest talk. On his return to us he shouldered his blankets and grip, starting for a wood camp on the river, after a talk with Cope. We were never told the cause of these desertions, but learned afterwards that the scout had run across Sitting Bull's command in the Dry Fork of the Missouri, not many miles from where we proposed to make our next camp, and being unable to induce the professor to give up his expedition, left us alone in an unknown country. With double labor to perform, we pressed on and made our camp on the river a few miles below Cow Island, on the opposite side at some old steamboat snubbing-posts. We made no other while Cope was with us. He took passage down the river about October 15. I find by consulting the following letter that Professor Cope had become confused in regard to the localities of the four specimens we found near Cow Island of the genus *Monoclonius*:

PHILADELPHIA, Dec. 21st, 1889.

Dear Mr. Sternberg:

I am going over the fossils you and Mr. Isaac collected on the N. side of the Missouri River in 1876. I send you a paper showing how far I have got along with the study. I want to ask you some questions. 1st, Did you get the *Monoclonius* you marked, at exactly the same spot as where I dug up (with your help) the bones of the animal I so named? If not, how far off did you get them? I refer especially to the animals figured on Pl. XXIII., figs. 2 and 2a.

2nd. Isaac got a lot of bones somewhere in the same neighborhood, I think further west. How far off was that? There are four separate animals, all supposed to come from the place where

I got *Monoclonius crassus*; two of these I got. Both are *M. crassus*. Two you got, one larger (*M. spenocerus*) and one smaller (*M. fissus*) than mine. It is about these latter that I want information. Marsh has been duplicating this work in his usual shameless style. According to him, nothing has been done in this field before. He made a good beginning by describing the horns of one of these fellows as a new species of bison. Answer soon.

Very truly,

E. D. COPE.

I remember distinctly helping the professor collect his type specimen. It was on the south side of the river, between our camp and Cow Island. The specimens I collected and those of Mr. Isaac were near together, on the north side of the river, about five miles below Cow Island Station. To my knowledge, Cope never collected on this side. He took passage on a steamboat the day after we crossed, about October 15. Mr. Isaac and myself made a camp about three miles below the station afterwards, and the material referred to was found some distance below our camp. These thick deposits Cope called Cretaceous No. 6, or Judith River group. So I was surprised to find none of the species of *Monoclonius* in the Judith River column. The fish *Hedronchus*, named in my honor, came, I am sure, from the bone-beds in the Dog Creek region. To help solve the problem of the age of these beds it seems to me one way would be to put the Dog Creek fossils in their proper place in the column, and not confuse them with the *Monoclonius* material that was only found by us near Cow Island. If the type localities are systematically studied and the stratigraphical characters fully understood, proof may be forthcoming that the *Monoclonius* beds are older than the Judith River. They are certainly forty miles further down the Missouri than the unmistakable Judith River beds that rest on the Fort Pierre and Fox Hills at Dog Creek.

CHARLES H. STERNBERG.

SEEDS BURIED IN THE SOIL.

NUMEROUS cases are on record in which seeds are said to have remained dormant in the soil for some considerable time, varying from a few years to many centuries. Such reports have always been and will continue to be of

much popular interest because many of these seeds, when taken, by chance, from their accidental burying ground and exposed to conditions favorable for germination, have, in many instances, indicated a remarkable prolongation of vitality. It must, however, be remembered that such reports are based chiefly on accidental results, in most cases being even highly speculative, and are, therefore, of but little value in furnishing reliable data as to the length of time seeds will retain their vitality when buried in the soil.

The time required for the completion of such experiments must necessarily extend over a number of years, and for this reason but very few actual experiments have been made. The most important are those of Dr. Beal, as reported in the *Michigan Farmer*, November 30, 1901, in which he found that seeds of twelve out of twenty-one species responded to germination tests after having been buried for twenty years.

In so much as the question is continually being asked, 'How long can seeds remain buried in the soil and still retain their power of germination?' we have started a series of experiments in connection with our work in the Seed Laboratory of the U. S. Department of Agriculture, with the hope of securing some definite data and thereby answering this question once for all. For these experiments we have taken 112 different samples of seed, representing 109 species, 84 genera and 34 families. These have been so selected as to include seeds of most of our common field and garden plants, as well as seeds of many of the grasses and our most noxious weeds. These seeds were first carefully counted, of most samples 200 seeds being taken; however, only 100 of some of the larger seeds such as beans, peas, corn, etc. The seeds were all of the harvest of 1902, save two of the duplicate samples of red clover.

Preparatory to burial the previously counted samples of seed were mixed with dry clay soil and packed in well-baked, porous clay pots of four, three and two inches diameter, depending on the size of the seeds; inverted clay saucers serving as covers for the various pots.

These pots were buried December, 1902, on the Arlington farm of the United States Department of Agriculture, in a heavy clay soil at three different depths. Eight complete sets are covered to a depth of six or eight inches, such as would take place in deep ploughing. Twelve complete sets are buried at a depth of twenty inches, where they will be comparatively free from the action of frost. Twelve more complete sets are buried from three to three and one half feet, thus insuring fairly uniform conditions as to temperature, moisture, etc.

In all 32 complete sets or 3,584 pots have been buried. It is proposed to take up one of each of these sets from time to time and test for germination. The present plan is to make the tests at the end of one, two, three, five, seven, ten, fifteen, twenty, twenty-five, thirty, forty and fifty years. With this scheme the last set of those buried at a depth of six to eight inches will be taken up for test after the lapse of twenty years, and, indeed, it is quite probable that most of this series will have germinated or decayed long before this; in fact we feel reasonably sure that many will succumb during the first year. Similar results will undoubtedly be had from those buried at greater depths, though here vitality will be retained longer. Many, of course, will live for a number of years; on the other hand, it will be quite surprising if any respond to germination tests at the end of fifty years.

J. W. T. DUVEL,

Assistant in Seed Laboratory, U. S.
Department of Agriculture.

SOME NEW GENERIC NAMES OF MAMMALS.

In preparing an index of the genera of mammals, a number of names have come to light which have been previously used for other groups. Some of these names are in current use and apparently have no synonyms which can be substituted for them. The following new names are therefore proposed:

Eosaccomys—new name for *Saccostomus* Peters, 1846, which is preoccupied by *Saccostoma* Fitzinger, 1843, a genus of reptiles.

Eucervaria—new name for *Cervaria* Gray,

1867, which is preoccupied by *Cervaria* Walker, 1866, a genus of Lepidoptera.

Helicotragus—new name for *Helicophora* Weithofer, 1889, which is preoccupied by *Helicophora* Gray, 1842, a genus of Mollusca.

Lophocebus—new name for *Semnocebus* Gray, 1870, which is preoccupied by *Semnocebus* Lesson, 1840, a genus of lemurs.

Morenella—new name for *Morenia* Ameghino, 1886, which is preoccupied by *Morenia* Gray, 1870, a genus of chelonians.

Nannospalax—new name for *Microspalax* Nehring, 1898, which is preoccupied by *Microspalax* Trouessart, 1885, a genus of Arachnida.

Necronycteris—new name for *Necromantis* Weithofer, 1887, which is preoccupied by *Necromantes* Gistel, 1848, a genus of Mollusca.

Neocothurus—new name for *Cothurus* Palmer, 1899, which is preoccupied by *Cothurus* Champion, 1891, a genus of Coleoptera.

Octodontomys—new name for *Neoctodon* Thomas, 1902, which is preoccupied by *Neoctodon* Bedel, 1892, a genus of Coleoptera.

Tapirella—new name for *Elasmognathus* Gill, 1865, which is preoccupied by *Elasmognathus* Fieber, 1844, a genus of Hemiptera.

Tytthoconus—new name for *Microconodon* Osborn, 1886, which is preoccupied by *Microconodus* Traquair, 1877, a genus of Pisces.

T. S. PALMER.

U. S. DEPARTMENT OF AGRICULTURE.

MUSEUM NOTES.

THE *Annual Report* of the director of the Carnegie Museum shows good progress in various directions, but particularly in the line of paleontology, where valuable additions have been made in the shape of specimens of the larger dinosaurs and of Oligocene mammals. Important additions have been made to the entomological collections, which are now among the most important in the United States, and there has been obtained by purchase the only specimen of the almost extinct *Rhinoceros simus* in this country. Pending the important additions to the museum building which are to be made the director pro-

poses to meet immediate wants by the erection of a laboratory building in which the work of preparing and mounting material for exhibition can be carried on.

The report on the 'Prize Essay Contest' for 1901 shows that this is an effectual method for attracting the public school children to the museum.

Accompanying the report of the director is a handsomely printed pamphlet giving an account of the seventh annual celebration of Founder's Day and containing the addresses delivered on that occasion by White-law Reid, R. W. Gilder and Joseph Jefferson.

It may be added that parts three and four, completing the first volume of the *Annals of the Carnegie Museum*, have just been issued.

THE *Annual Report* of the director of the Field Columbian Museum for 1901-1902 notes at the outset that the building has about reached the limits of repair. It is to be hoped that an arrangement may soon be made by which the large and valuable collections of this institution may be properly housed. The museum did much field work during the past year, resulting in important accessions to the divisions of anthropology, zoology and paleontology. The attendance has increased and the series of excellent lectures were well attended, both these facts marking a growing interest of the public in the museum.

From a comparison of reports it would seem that museum lectures are vastly better attended in the United States than in Great Britain, but the lavish use of lantern slides here doubtless accounts for a part of the difference. Like the Carnegie Museum, the Field Columbian Museum makes a direct effort to attract the pupils of the public schools, and with equal success.

Of particular interest are the descriptions, with illustrations, showing methods of installation of corals, paleontological specimens and economic collections in the department of botany. It is something of a question if the new cases are not a little too severely simple in their design, for while the prime object of a case is to protect its contents, a

case is unavoidably a feature of the hall containing it. It would, therefore, seem to call for some architectural treatment, and the total abolition of cornice and sash moldings gives a case too much the appearance of a mere box.

Besides the illustrations referred to there is a plate of a group of zebras, and views of the groups recently completed by Mr. Akeley, showing the Virginia deer in spring, summer, autumn and winter. These have been in preparation for a long time past, and are unquestionably the most elaborate of the kind anywhere, and the most successful of attempts to imitate nature in museums. F. A. L.

THE AMERICAN MUSEUM OF NATURAL HISTORY.

THE 'Thirty-Fourth Annual Report' (that for 1902) of the American Museum of Natural History was placed in the hands of the officers of the Park Department on May 1. It includes, besides the president's report, the financial statement for the year, the list of accessions, and lists of the members, fellows and patrons of the museum.

A summary of the president's report is as follows:

The timely increase on the part of the city of its annual appropriation for maintenance (from \$135,000 to \$160,000) enabled the museum to complete its year's work without calling upon the trustees for additional funds. The city also appropriated \$200,000 for a power and heating station.

Heretofore it has been necessary to borrow money at the beginning of each year to pay the current expenses for maintenance, pending the refunding of such sums by the city, but at the last annual meeting of the board of trustees one of its members very generously gave \$15,000 to be used as a capital to meet the current bills, pending their repayment by the city, the only condition of the gift being that the treasurer's report should show a credit balance of \$15,000 at the close of each year. The terms of the gift have been fully complied with.

At the annual meeting of the board of

trustees held in January, 1902, expenses from the general and maintenance funds were authorized to the aggregate amount of \$210,260, involving a deficit of \$19,560. The report of the treasurer shows that the museum has not drawn upon this deficit. The invested funds, however, have not been materially increased, and in the absence of any large income the museum is obliged to depend upon the liberality of friends for the development of its collections.

The financial transactions of the museum are now divided into three separate accounts: (1) City maintenance account, covering the receipts and disbursements of moneys received from the city; (2) general account, including the receipts and disbursements of the income from invested funds, membership and admission fees, state superintendent of public instruction, and contributions (not for specific purposes) from the trustees and others; (3) endowment and investment account, including the receipts, investments and disbursements of moneys received from bequests, and contributions for specific purposes. The sums received from bequests and the interest thereon are invested in securities for the permanent endowment. Special funds are kept apart.

The membership of the museum increased during the year. The field parties covered a large territory, and the museum acknowledges the aid rendered by the various railroad companies in lessening the cost of transportation of the men and of the material collected.

The large attendance at the museum by the public and by teachers with their classes, and the attendance upon lectures given at the museum, were gratifying. Several scientific societies held their regular meetings in the museum building. In October, 1902, the International Congress of Americanists held its thirteenth annual session at the museum, and there were present delegates from many foreign countries. The subjects discussed related to the native races of America and the history of the early contact between America and the old world.

Certain facts connected with the work in

the several departments of the museum are mentioned.

Dr. Hovey, of the geological department, was sent by the museum on an expedition to Martinique and St. Vincent in May, 1902, and his treatment of volcanic phenomena in general and of the eruptions of Mt. Pelé in particular has received favorable comment throughout the scientific press.

The additions to the museum collection of mammals were unusually large.

The gift from the Peary Arctic Club of about one hundred mammals, collected by Commander Peary on his last arctic expedition, is especially noteworthy, and the museum is now doubtless by far the richest in the world in mammals from arctic America. Donations of specimens in the flesh were received from the New York Zoological Society and the Central Park Menagerie. The Andrew J. Stone Expedition continued its work of making collections of mammals of the Alaskan peninsula.

Material was collected in the Bahamas and Virginia for special bird groups.

In the department of vertebrate paleontology, the collections were enriched by expeditions maintained in the field, and the establishment of a fund by a member of the board of trustees for providing material to illustrate the origin and development of the horse produced immediate results of the highest importance. The purchase of the Cope collections was effected. These include fossil reptiles, amphibians and fishes, and the Pampean collection of fossil mammals from South America.

During the year a number of archeological collections not before exhibited were installed, notably the Hyde collections from the ancient cliff-houses, burial-caves and ruined pueblos of Colorado, Utah and New Mexico. Among the new exhibits installed during the year is the special exhibit of a portion of the material obtained during the researches in the Delaware valley, which have been carried on for over twenty years. It seems to show that man was in the valley of the Delaware at the

time that certain of the glacial deposits and those immediately following were made.

An exceptionally large amount of ethnological material was installed. Early in the year, the Chinese collections were placed on temporary exhibition, and in the spring work was begun on the installation of the Siberian collections of the Jesup North Pacific Expedition.

The work of the Jesup North Pacific Expedition progressed satisfactorily. The aim of the expedition to collect full information of all the tribes of the North Pacific coast has in the main been accomplished. The whole district from Columbia River in America westward to the Lena in Siberia, has been covered fairly exhaustively, and it is already evident that the relationship between Asia and America is much closer than has hitherto been supposed.

The Huntington California Expedition and the North American Research were continued, and much information gained in regard to certain of the native tribes of America.

The East Asiatic work of the Expedition to China promises important scientific results.

The Hyde Expedition carried on work in the southwest and in northern Mexico during the year.

The results of the work of the Mexican Expedition throw much light on the burial customs of the ancient Zapotecs, and the collections obtained add materially to the importance of the collection in the museum. Rare specimens of gold, copper and jadeite secured by the expedition, added to those already in the museum, make this part of the Mexican collections the best in any museum. From the Duke of Loubat, the museum received a gem collection of great importance from the state of Oaxaca.

Local explorations were carried on in the Shinnecock and Poospatuck reservations on Long Island and Staten Island and at Shinnecock Hills.

Several additions were made during the year to the gem collection in the department of mineralogy, namely, five magnificent crusts of amethyst, a large yellow sapphire, two

parti-colored sapphires, an immense star sapphire and a curious archaic axe of agate, gifts of Mr. J. Pierpont Morgan. A splendid collection of gold and silver coins from the Philadelphia Mint, the gift of Mr. Morgan, was placed in the gem room.

The department of invertebrate zoology received an important accession in a collection of West Indian corals, actinians and alcyonarians collected in Jamaica.

The New York Zoological Society and the Department of Parks were the principal donors of reptiles and batrachians.

In the department of entomology, the Hoffman collection of butterflies was transferred to the new cases, and the Schauss collection of moths provisionally arranged. From the Black Mountains of North Carolina, 7,000 specimens were obtained for this department.

The publication of the scientific results attending the investigations of the museum progressed during the year.

Several courses of lectures were offered, under various auspices: To teachers, to members of the museum and to the public (holiday course), under a grant from the state; to teachers, by the museum in cooperation with the Audubon and Linnæan societies; to the public, by the city department of education in cooperation with the museum.

The president sums up his report in the following words: "In concluding this my twenty-second report, I take pleasure in assuring the members of this board that the past year has been one of achievement. The increase in the annual appropriation, the growing popularity of the lectures, the large sums spent for laboratory research, the long list of publications, the opening of new exhibition halls, the appropriation by the city of \$200,000 for a new power house, the receipt of large invoices of ethnological material from Siberia and China, the conclusion of negotiations leading to the purchase of the Cope collection, and the departure of several exploring expeditions, are only a few of the indices of activity at the museum, of the generosity of our friends, and of appreciation on the part of the city officers and the visiting public."

SCIENTIFIC NOTES AND NEWS.

DR. EUGENE HODENPYL, of New York, has been elected president and Dr. Simon Flexner vice-president of the American Association of Pathologists and Bacteriologists.

DR. A. C. ABBOTT, professor of hygiene at the University of Pennsylvania, has been appointed chief of the Bureau of Health at Philadelphia.

THE freedom of the city of Rome was conferred on Mr. G. Marconi on May 7.

THE Stockholm Society of Anthropology and Geography has awarded its Vega medal to Professor von Richthofen, of Berlin.

DR. M. NÖTHER, professor of mathematics at Erlangen, has been elected a corresponding member of the Paris Academy of Sciences.

CAMBRIDGE UNIVERSITY has conferred the degree of D.Sc. on Dr. Robert Bell, F.R.S., acting director of the Geological Survey of Canada.

DR. FLORIAN CAJORI, professor of mathematics at Colorado College, has been appointed representative of the United States on the international committee of the Congress for the Study of the History of the Sciences, which committee will make arrangements for the next meeting of the Congress at Berlin in 1906. Officers of the committee are: President, P. Tannery, Paris; Secretaries, P. Giacosa and G. Loria, Genoa.

PROFESSOR C. V. HARTMAN, the well-known archeologist, whose work upon the antiquities of Costa Rica was recently published by the Royal Geographical Society of Sweden, and who several months ago accepted service in the Carnegie Museum as the curator of archeology and ethnology, is at present in Costa Rica in the interest of the museum. The Carnegie Museum has secured by purchase from Senor Don Pedro Maria Velasco the extensive collection of Costa Rican Antiquities at present on deposit in the Archeological Museum of the University of Pennsylvania. Dr. W. J. Holland, the director of the Carnegie Museum, announces that it is not his intention, however, to remove the collection from the temporary custodianship

of the museum in Philadelphia, until a later date.

SECRETARY CORTELYOU, of the Department of Commerce and Labor, has appointed a commission to take under consideration all the statistical work of the bureaus included in his department for the purpose of recommending any changes that can be made for improving this branch of the service. The commission consists of Mr. Carroll D. Wright, commissioner of labor, chairman; Mr. S. N. D. North, of the Census Bureau, vice-chairman; Mr. Frank H. Hitchcock, chief clerk, Department of Commerce, secretary; Mr. James R. Garfield, commissioner of corporations; Mr. O. H. Tittmann, superintendent Coast and Geodetic Survey; Mr. George M. Bowers, commissioner of fish and fisheries; Mr. F. P. Sargent, commissioner-general of immigration, and Mr. O. P. Austin, chief of the Bureau of Statistics.

THE New York *Evening Post* says that Professor L. M. Hoskins, of the civil engineering department of Stanford University, has been appointed by the Carnegie Institution a member of the committee of investigation to conduct a joint inquiry into mathematical, astronomical, physical, chemical and geological phases of the earth and problems that lie in the common domain of these sciences.

PROFESSOR ISRAEL C. RUSSELL, of the department of geology in the University of Michigan, will make an extended journey in central Oregon during the coming summer, for the purpose of studying the geology and especially the artesian conditions. The work is to be done for the United States Geological Survey, and is in continuance of explorations in the arid portion of the West, in which Professor Russell has been engaged for several years.

DR. GEORGE C. MARTIN, assistant in paleontology at Johns Hopkins University, is in charge of an expedition, sent out by the U. S. Geological Survey to study coal and oil resources of the Cook's Inlet region in Alaska.

DR. THIELE has been made a curator in the Zoological Museum at Berlin.

PROFESSOR H. M. HURD, of the Johns Hopkins University, will give the address before the Medical School of Yale University at the approaching commencement, his subject being 'The Duty and Responsibility of the University in Medical Education.'

THE Croonian lectures before the Royal College of Physicians of London will be delivered by Dr. C. E. Beevor on June 9, 11, 16 and 18. The subject will be muscular movements and their representation in the central nervous system. The first course of FitzPatrick lectures founded by Mrs. FitzPatrick in memory of her late husband, Dr. Thomas FitzPatrick, will be delivered by Dr. J. F. Payne on June 23 and 25. He has chosen for his subject English Medicine in the Anglo-Saxon and Anglo-Norman Periods.

DR. W. M. BAYLISS, assistant professor of physiology at University College, London, is bringing an action for libel and slander against the Hon. Stephen Coleridge, on the ground of certain statements made in a speech on May 1, at the annual meeting of the National Antivivisection Society.

PROFESSOR J. H. GORE, of the Columbian University, has accepted the position of commissioner general for the Siamese government at the St. Louis Exposition. The Siamese government will erect on the grounds a reproduction of one of the most striking buildings of Siam.

AN expedition in charge of Dr. F. A. Cook, of Brooklyn, is to explore Mount McKinley and other Alaskan mountains under the auspices of the Geographical Society of Philadelphia and the Arctic Club, of New York.

PROFESSOR JACOB REIGHARD, of the University of Michigan, has been granted leave of absence for the last eight weeks of the academic year in order that he may investigate the habits and methods of artificial propagation of the black bass. A laboratory has been fitted up at the state bass hatchery at Mill Creek in Kent County, where Professor Reighard is working under the auspices of the Michigan Fish Commission.

THE British Institution of Civil Engineers has presented to the Italian government a

bust of George Stevenson to be placed in the railway station at Rome.

A COMMITTEE, consisting of Professors W. K. Brooks, W. H. Howell, W. T. Sedgwick, E. A. Andrews and Theodore Hough, has arranged for a portrait of the late Professor H. Newell Martin, for many years professor of physiology in the Johns Hopkins University. It is to be a Copley print, a sepia-tone platinotype 14 x 11 inches, made by Messrs. Curtis and Cameron, of Boston. The cost of the picture is \$5, and it may be obtained from Dr. Theodore Hough, Massachusetts Institute of Technology, Boston, Mass.

THE death is announced of Mr. Clarence Bartlett, who recently retired from the post of superintendent of the London Zoological Gardens; of M. Worms de Romilly, the French physicist, and of Professor Wigburgh, of the School of Mines of Stockholm.

THE first *conversazione* of the Royal Society was held on the evening of Friday, May 15, at Burlington House.

A GEOGRAPHICAL society has been founded at St. Petersburg in connection with the university, with Professor Brunov as president.

THE International Association of Botanists has held its first congress at Leyden under the presidency of Professor Goebel, of Munich.

MR. H. L. FLORENCE has given £1,000 to the Cancer Research Fund, London.

THE Canadian government has declined to make further contribution to the Marconi system of trans-Atlantic telegraphy, the minister of finance stating in the House of Commons that it had not been as successful as expected.

A UNIFORM time, based on the 30th meridian, or two hours east of Greenwich, has been adopted by all the South African governments, with the exception of German Southwest Africa.

THE Gulf Biologic Station, established by the state of Louisiana at the mouth of the Calcasieu River in Cameron Parish (county), will be opened on July 1, 1903. A large laboratory building has been erected and all necessary equipment for investigation of

marine life has been provided. Board may be procured near the laboratory for \$18.00 per month. Collectors and investigators are especially invited. For further particulars apply to Professor H. A. Morgan, Louisiana State University, Baton Rouge, La.

WE learn from the *Geographical Journal* that an association for the advancement of scientific research in the Adriatic has been founded in Vienna. At the inaugural meeting, which was held in the university on March 24, the proceedings were opened by the Rector of the University of Vienna, Hofrath Gussenbauer, and after a speech by the president of the new association, Count Vetter von der Lilie, Professor Berthold Hatschek delivered an address on 'Marine Research.' The work of the association, which will cooperate with the Government biological station at Trieste, will in the first instance consist in establishing and maintaining a marine aquarium at Trieste, and in fitting out a suitable steam-vessel for the scientific exploration of the northern part of the Adriatic.

THE *London Times* states that a report has been received by the Liverpool School of Tropical Medicine from the Senegambia expedition. Dr. Dutton and Dr. Todd, writing from McCarthy Island in the Gambia, state definitely that trypanosomiasis is prevalent over the whole of the British colony of the Gambia. They have now completed the examination of over 1,000 natives. They have also discovered that trypanosomiasis is extremely common among all the horses there, and is chiefly responsible for the great mortality in those animals. Dr. Dutton and Dr. Todd have now left the Gambia to continue their researches into the disease in the French Senegal settlement, which adjoins that of the British.

FOREIGN journals state that the Viceroy of India will devote the donation of £20,000 from Mr. Henry Phipps to two objects, a laboratory for agricultural research, to be called the Phipps Laboratory, which will probably be situated at Dehra Dun, and the provision of a second Pasteur institute in the south of India similar to that at Kasauli. The dona-

tion will be devoted to the requisite buildings, while the site will in both cases be provided by government, which will also in the first case contribute to and in the second undertake the cost of maintaining the institution.

SIR J. WOLFE BARRY, chairman of the engineering standards committee, writes to the *London Times*, pointing out that the lists of rolled sections recently issued deal only with the sections used in ships, bridges, general building construction and underframes of railway rolling stock. These cover but a small portion of the work which is being carried out by the committee. In addition to the above subjects, the following subcommittees are at work on equally important matters and will shortly report to the main committee. (1) Three committees on rails and tires engaged in drawing up a series of standard railway and tramway rails for use in this country and the colonies. (2) Four committees on the standardization of locomotives, which question, in so far as it relates to Indian locomotives, has been officially referred to the Engineering Standards Committee by the government of India. (3) Four committees on the question of the standardization of electrical plant. The standardization of pipe flanges will also before long be taken in hand, in cooperation with the Institution of Mechanical Engineers. Another sphere of the committee's operations (only as yet commenced) will be the issuing of standard specifications and standard tests for materials.

WE learn from the *Geographical Journal* that at its annual meeting, the Russian Geographical Society awarded its Constantine gold medal to P. K. Kozloff for his last researches and geodetical measurements in Tibet, his excellent maps, and most valuable zoological and botanical collections. The Count Lütke medal was awarded to N. M. Knipovich, for his researches in the Arctic Ocean, and to N. A. Sokoloff, for his geological and geographical work. The large gold medals of the section of ethnography were awarded to Professor V. A. Zhukovsky, for

his work on folk-lore in Persia, and to V. N. Perets, for ethnographical work. The Semenoff medal was given to L. I. Brodovsky, for the map of Manchuria which he has compiled. Small gold medals were given to A. K. Kuznetsoff, for the work he has done in the museum of the Chita (Transbaikalian) section of the Geographical Society; to V. H. Ladyghin, for his work during the Kozloff Tibet expedition; and to L. S. Berg, for his exploration of Lake Aral. A number of silver medals for various minor works were given to several persons. The greatest achievement of the Geographical Society was the visit to Lhasa by a member of the society, the Buryat Lama, M. Tsybikoff, who has also been at a number of monasteries in Tibet, and has brought back 319 volumes of various works of Buddhist philosophy, medicine, history, and so on.

UNIVERSITY AND EDUCATIONAL NEWS.

PROFESSOR HUGO MÜNSTERBERG announces that the sum of \$150,000 for the Emerson Hall of Philosophy, Harvard University, has been secured.

THE University of California has received from Mr. W. M. Pierson a telescope with an eight-inch lens, and from Mrs. A. S. Halliday \$500 for the library of mechanical engineering.

THE trustees of Columbia University have appropriated \$8,000 for the erection of two buildings at Morris, near Litchfield, Conn., to be used as dormitories for the summer school of surveying.

ANNOUNCEMENT is made of the establishment of four Yale scholarships by Chicago Yale alumni, who give \$2,500 a year for deserving and needy Illinois students to be chosen by the faculty in the academic department and scientific school.

GOVERNOR ODELL has vetoed the item appropriating \$10,000 for supporting the School of Forestry at Cornell University.

THE summer session of the University of Maine will open June 29, and continue for five weeks. For this summer term courses are offered in physics, chemistry, botany,

mathematics, astronomy, history, English, modern languages, Latin and Greek.

JAMES HARKNESS, A.M. (Cambridge and London), since 1888 professor of mathematics at Bryn Mawr College, has been appointed by the board of governors Redpath Professor of Mathematics at McGill University; and H. M. Tory, M.A., D.Sc., has been appointed associate professor.

DR. J. ROLLIN SLONAKER, associate in neurology, University of Chicago, has accepted the position of assistant professor of physiology in Leland Stanford Jr. University.

DR. THEODORE HOUGH, of the Massachusetts Institute of Technology, has been appointed assistant professor of biology at Simmons College, Boston.

G. W. STEWART, instructor in physics at Cornell University, has been elected professor of physics in the University of North Dakota.

DR. G. W. WHITNEY has been appointed reader in philosophy at Bryn Mawr College.

APPOINTMENTS at the New Mexico School of Mines have been made as follows: Royal P. Jervis, M.E., professor of mining; Rufus M. Bagg, A.B. (Amherst), Ph.D. (Johns Hopkins), professor of mineralogy and petrology; Gay M. Hamilton, of the University of Nebraska, instructor in geology. Professor C. L. Herrick, formerly president of the University of New Mexico, and the Hon. Daniel H. McMillan, judge of the U. S. District Court, will give courses of lectures, respectively, on geological philosophy and mining law.

AT the University of Birmingham Miss Helen P. Wodehouse, fellow of Girton College, Cambridge, has been elected assistant lecturer in philosophy.

IN consequence of ill-health Professor G. V. Poore, M.D., has found it necessary to resign his chair of medicine and clinical medicine in University College, London, and his physicianship to University College Hospital. The council, in accepting the resignation, unanimously adopted a resolution testifying to their high appreciation of the services Dr. Poore had rendered to the college and hospital during the past thirty-five years.